



FACTORS IMPACTING SMALL PROJECT EXECUTION

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Chapter 1 Introduction

Background

Many companies use project manuals that define time-tested procedures for large project execution and delivery. However, large project delivery processes are not easily ‘scaled down’ for small projects and, by some standards; fail to deliver the projects in an effective manner. Factors contributing to the reduced effectiveness include:

- The compressed project life cycle reduces team effectiveness and suggests that measures of project success commonly associated with large projects may, in fact, be inappropriate for teams managing small projects.
- Small projects are likely to experience “expertise” gaps since the opportunities for full-time staff are smaller and part-time assignments may not achieve the integration that leads to optimal solutions of problems. In some instances this expertise could be ‘borrowed’ or ‘loaned’ for a short time, but multi-disciplined or multi-skilled design and construction staff would reduce problems of expertise.
- Due to perceived “value,” small projects often get placed into low organizational priority or “low visibility” positions. Priority and visibility are important in staffing decisions, resource allocation, and the “participation” level of upper management.
- Small project documentation often falls into one of two extremes. It is either excessive or cumbersome when it tries to follow the same process used for large projects, or it is inadequate when no formal process has been established.

The abbreviated list is not an exhaustive treatment of small project variations or problems compared to ‘large’ projects. It is provided to demonstrate that small projects have many unique characteristics, face significantly greater problems within organizational boundaries, and may be driven by success factors unlike the project success factors for larger projects.

As noted above, large projects generally have the advantage of well-defined process and procedure manuals that define the steps and actions necessary to deliver the project. However, small project management teams often do not have dedicated process and procedure manuals and they attempt to adapt the large project manuals where appropriate. Thus, small project execution may result in less than optimal project cost, quality, and schedules when executed using standard project delivery systems. It is believed that the processes and factors contributing to small project success may be different than those identified on large projects.

By improving the effectiveness and consistency of the small project delivery process, the entire industry will benefit. Identification of successful practices will enable others to change or implement the suggested methods. Financial benefits from the changes are difficult to forecast, but it is reasonable to speculate that successful small projects have savings potential for owners and improved competitiveness for the industry. This research is highly applicable to all sectors of industry engaged in execution of small projects. Owners will benefit from savings created through improved delivery processes for the 40-60% of current capital budgets now spent on “small”

projects. This work will assist contractors and vendors in aligning their organization and procedures to better meet owner's small capital project programs

Purpose

The purpose of this project was to research and document the best practices associated with the small project execution process. Included within the best practice concepts was the examination of technology applications to the small project environment.

Scope

The focus of this project was on small capital projects whose characteristics, as defined by a combination of complexity, organization, work volume, and staffing requirements, require the use of modified project management and execution processes or procedures. Small projects are not easily definable. A monetary definition on the boundary of small projects was used in the research to assist in limiting the project scope. Projects were limited to between \$100,000 and \$2,000,000. It was anticipated that other organizations identify or categorize small projects based on factors other than simply the dollar value or have dollar value limits that would be significantly different. It was also anticipated by the research that management practices and procedures would be highly variable within the industry. The objectives of this study were established to refine the focus of the research to be accomplished by this project.

Objectives

This research seeks to resolve the following objectives:

- Identify the problems in the small project execution process.
- Identify approaches and modified procedures, processes and resources for small projects.
- Identify the best practices and key factors for successful small project execution.
- Identify leading edge technology applications for small projects.
- Identify opportunities and development of personnel for multi-skilled design and construction assignments.

Research Approach

The idea behind this research is that there exists an opportunity to continue to improve the overall competitiveness of the industry by researching and documenting successful small project execution processes. The approach to the research was to collect and evaluate information and data from small project processes of owners and contractors. Data to support the success of the processes was solicited from Construction Industry Institute (CII) member companies in the form of small project execution manuals and related documentation that can demonstrate process improvement. Empirical and anecdotal data will be obtained to support the effectiveness of studied processes. The following tasks are established to achieve the project objectives.

Task 1 – Literature Review. An excellent starting point for the literature review was the Manual for Small (Special) Project Management (SP13) and related CII research on project organization, scope definition, and delivery systems. Suggestions and concepts from these previous works were appropriate to consider for small project adaptation. The purpose of the detailed review was to avoid duplication of effort and to identify gaps in practices already identified for small projects. Information and data related to project delivery systems used in other industries would be investigated where the projects have similar characteristics. A detailed search of other literature on small project management will be examined for applicable information and data.

Task 2 – Data Collection. Data collection was a two-stage process. First, telephone contacts and focused surveys on small project execution problems, issues, technology applications and solutions were issued to cooperating company project managers. Participants in the survey were requested to complete surveys and to provide appropriate supporting documentation. Confidentiality of proprietary information was strictly controlled with access only permitted to the researchers. Contributors to the survey process were requested to act as a follow-up resource contact for the project team. A fairly even balance between owner, designer, and contractor responses was desired. In addition to project execution processes, key performance criteria for projects were collected. The second phase, site visits were conducted. During the site visits clarification of survey questions were recorded in addition to interviewee observations regarding

Task 3 – Best Practices Identification. Best practices often are not ‘benchmark’ best practices but consensus practices of the industry. Project performance indicators obtained in the data collection phase were used to identify those practices that consistently achieve better performance. In addition the information on successful projects from the literature search was considered in identifying best practices.

Task 4 – Research Summary Report. This report was prepared to gather the information and data from the project. The report is organized as follows:

- **Chapter 1** is the project background, introduction and task description.
- **Chapter 2** is a summary of the literature on small project processes and success factors. The purpose is to identify the key practices identified by others that influence small project execution.
- **Chapter 3** summarizes the data from completed surveys.
- **Chapter 4** presents data analysis and a consensus of ideas from the interview process.
- **Chapter 5** summarizes the research findings and concludes with several recommendations for further consideration on small project execution research.

Chapter 2 Literature Survey

Background

The original work performed for the Construction Industry Institute on small projects was published in July 1991, *Manual for Small (Special) Project Management (SP-13)*. At the time it was published it truly was a special publication within the project management body of knowledge that CII had compiled and disseminated. Until SP-13, the primary focus of CII had been on improving large project processes. Therefore, SP-13 is an important publication to review as a point of beginning for this research.

This chapter is organized in a somewhat unconventional manner when compared to similar background literature chapters in a research project. Typically the intention of a background chapter is to synthesize current body of literature on a specific topic. Appropriately performed, the breadth of project management topics would result with a very lengthy primer on project management, with occasional reflections on small projects. Therefore, the choice was made to avoid ‘reinventing of the wheel’ and keep the focus of the background section, as much as possible, on the more limited body of literature specifically dedicated to small project issues. The exception to this was the review of project success factors, where small and large projects tended to blend together in the research.

Small Projects Defined

Immediately the problem arose on defining what would be considered as a small project. The CII *SP-13* publication approached it by describing the differences between large project systems and small project systems. One clarification should be highlighted before the literature is examined. Large projects are typically stand-alone ventures. When viewing small projects in a stand-alone fashion, it is easier to identify differences. The focus appropriate to the vast majority of the companies involved in the research was small capital projects in a program of work or as elements of a capital project budget that were dedicated to a group of small projects. The literature further confuses the issue further by assuming, in many instances, that small contractors execute small projects. Thus, examining the literature to help clarify the question, “What is a small project?” was included in the literature focus and those findings will be reported in this section.

Literature Survey Organization

The first overview covers the primary issues and solutions presented in *SP-13*. This information is followed by information extracted from the limited body of literature on small projects. The subject area format chosen for presentation follows the subject areas of project management research used by the CII. The first five subject areas follow the project execution process from front end planning through start-up and operations. The remaining areas are in-depth views at primary subject areas in project management.

Special Publication 13 (SP13)

SP-13, Manual for (Small) Special Project Management was prepared by an Action Team that examined and identified the significant problems unique to small projects. They studied potential solutions and presented their solutions under three broad classifications as follows:

- The Organizational Approach
- Guidelines for the Planning Phase
- Guidelines for In-process Management

The remaining six chapters in *SP-13* focus primarily on good management practices that would best fit small projects. Most of the content in these sections represents fundamental management practices tailored to small projects. Table 2.1 was prepared from the problems and solutions sections of *SP-13*. Detailed explanations of each issue and solution are provided in *SP-13* and are not repeated in the table. The subject areas used in Table 2.1 were adopted from the proposed knowledge area organization used by the Construction Industry Institute to establish a consistent outline between the survey and research publications. In reclassifying the information used in Table 2.1, it was recognized that some topics could arguably be listed in more than one subject area. Therefore, some of the solutions proposed in *SP-13* have been associated with areas not originally contemplated by the Action Team that prepared the document. This classification reflects an interpretation and viewpoint of the author of this research report.

Literature Review

The review of the literature is limited to those articles and books specifically addressing small capital projects executed by large owner organizations. The articles on small contracts or small contractor management problems generally had limited value in the context of this research project. The search was limited to materials applicable to small projects from domestic and international sources. In some cases conference articles and limited release publications (referenced by authors) could not be recovered. The limitation on the scope of the literature review was necessary to maintain focus on small project activities and not rewrite the entire body of knowledge on project management.

Facility Management Problems

El-Bibany, et.al. (1996) in their analysis of project management functions from a facility management function identified a number of problems faced by multiple facility owners. The authors did not represent that there was any difference between this level of project management and large capital project management. Thus the problems they have identified are presented as an overview. The problems encountered in multiple facility ownership applicable to small capital project management are as follows:

- Some seasonal project demand fluctuation
- Lack of an accurate and efficient project priority system
- Resource allocation created by the above elements
- Early commitment to time and cost without accurate information
- High project load carried by each player
- Lack of a system to coordinate work at a project level
- Higher level of detail activity by project manager
- Lack of an organizational responsibility/reward system for project management in the systems studied.
- Operation of the system governed by external constraints.

Table 2.1 Summary Review of SP-13 Special Projects Manual

Subject Area(1)	Issues Identified In SP-13 (2)	Solutions Suggested In SP-13 (3)
FRONT END PLANNING	- Poor scope definition a frequent problem - Risk proportion – low dollar projects that can stop the entire operation	- Structured approach to risk management - Owners – develop project road map - Use scope definition checklists
DESIGN	- Engineering purchased in a sequential fashion with go/no go decisions - Cost is larger proportionally	- Use strong matrix approach in design (people topic) - Freeze project scope – manage scope growth - Work breakdown structure/establish work hour and cost budgets - Incorporate constructability - Concurrent owner review - Coordinate with procurement
PROCUREMENT	None Clearly Identified	- Capitalize on vendor expertise even during design - Validate procurement milestones - Include contingency time in materials orders - Use modularization concepts - Limit sub tier subcontracting - Relate procurement to the schedule
CONSTRUCTION	None Clearly Identified	- Contractors should establish area or plant offices - Computerize materials management - Use a startup team - Visit Site and understand scope - Use WBS and develop supporting plans - Develop Project strategy document - Promote communication - Do not start work without the resources
START-UP & OPERATIONS	None Clearly Identified	- Operability, and maintainability considered in design - Seek operator input

Table 2.1 Continued

Subject Area(1)	Issues Identified In SP-13 (2)	Solutions Suggested In SP-13 (3)
PEOPLE	- Personnel assigned to small projects are often inexperienced personnel - Multiple project responsibilities for a single manager - Poor career attractiveness (stability in larger project) - Lost expertise – mentors for younger people	- Create appropriate manager titles & give PM authority - Select people with proper attributes - Use only experienced Personnel/with right experience - Maintain skills database & use personality profiles - Consider consultants and retired personnel - Maintain core special projects group - Cross train/maintain standing teams - Expert centers
PROJECT PROCESSES	Reinventing the wheel	- Integrate small project management into TQM program - Share lessons learned - Establish written procedures & standard forms etc - Limit owner reviews
PROJECT CONTROLS	- Short duration - Poor basis for control - Inapplicable standard control systems	Use formal project controls
CONTRACTING	- Contractor Competence -hard to get a good contractor for a small project - Subcontracting vs. direct hire - Large contractors tend to organize according to market segment; smaller cannot	- Partner with subcontractors and vendors - Limit contractor liability - Include incentives
SAFETY, HEALTH AND ENVIRONMENT	Safety and quality easily compromised on small projects	Emphasize safety and health
TECHNOLOGY AND INFORMATION SYSTEMS	Lack of computer literacy	- Computerize project controls - Promote computer literacy - Consider bar coding
MISCELLANEOUS	- Regulatory requirements applied with equal force - Remote Location	- Make small project assignments an honor not penalty - Employ team building - Pay scale differential - Be cautious introducing new procedures or technology

Notes: (1) Topic headings defined by CII areas of knowledge

(2) Classification of the issues is the responsibility of this author, not the Action Team for SP-13.

- Interaction with and dependence on other internal divisions increases the level of uncertainty.

These factors would appear to have some universal application to any project management system working with a large number of small projects with a larger organization. Their work took a broad view of developing improved processes and demonstrates the problems associated with attempting to isolate the issues without a guiding framework for classification.

Small Project Features

Westney (1985), developed one of the few textbooks dedicated to small project management. The author identifies many of the features of small projects that make them a unique challenge. Collected from various sections of the text the following problems or issues were identified:

- “Turnaround” projects that occur on critical manufacturing or process units have a large potential to assist or damage profitability. Many projects have disproportionate risk to their value
- Many small projects are in a production environment which increases the number of organizational interfaces
- Short timeframe for small projects
- Operating environment often dictates process and procedures
- Plants are organized for production, not engineering and construction
- Special project control problems
 - Short project life
 - Shared responsibility among departments
 - Problems in obtaining data
 - Many projects to be controlled simultaneously
- Standard procedures and techniques for large projects do not fit
- Need a method to accumulate cost and schedule data to improve resource management, forecasting, and reporting
- Need a consistent approach to projects – but be adaptable to existing procedures

Also introduced in the early section of the book were criteria for small project management techniques.

1. A standard approach. Each small project is different but there is a need to assure efficiency and consistency in the management of the projects. A standard approach is more likely to be used and understood, but it also needs to have sufficient flexibility to be effective.
2. Simple systems and techniques. Although the management problem is complex, the personnel who will be exposed to project management requirements will need appropriate training.
3. Fast response. Short durations indicate a need for techniques that provide information and responses quickly and efficiently. Any change in the host plant environment is likely to impact the schedule and resource availability.

Westney also illustrated the complexity facing a project manager for small projects in a very effective and concise manner. Table 2.2 is a modified version of the original comparison. This table illustrates the problems facing small project managers from strictly a quantitative look at how fundamental parameters change for a similar dollar volume of work on large projects.

Although the table suggests that a full time project manager and formal controls are not used for small projects, the project manager is a full time project manager for a large number of independent projects. Project controls are not as formal for small projects, but small projects do require project control systems.

Table 2.2 Managing Small vs. Large (Westney 1985)

Parameter	Hypothetical \$50 million in Capital Project expenditure	
	Large Project	Small Project
No. of Projects	1	100
No. of Estimates	1	100
No. of Schedules	1	100
No. of Purchase Orders and Subcontracts	100-200	500-1000
Full time PM team	Yes	No
Formal Control Procedures	Yes	No

Multiple Small Projects

A book on *Project Management of multiple projects and contracts* edited by Loftus (1999) showcases small capital project problems as:

- Too many projects with too little capital available
- Too few resources to manage all the projects
- Project definition is imprecise
- Project authorization process is not understood (including time to achieve authorization)
- Authority to approve expenditure inappropriate to the task
- Existing workload in the capital projects department will be ignored by person who authorizes the next project

Their prioritization is described by the following categories:

- Essential (cannot be avoided or delayed)
- Desirable (cannot be avoided but may be delayed)
- Opportunity (can be avoided and delayed but offers acceptable return on investment)
- Other (anything else and projects under investigation)

This ranking process is applied in the project process cycle at least six months before the beginning of the next financial year.

The elements of scope definition, timing, staffing, budgets, and workload are common between Loftus and Westney. These and additional factors from the literature review, specific to small capital projects, are organized using the headings provided in Table 2.1. Some citations will repeat in several sections due to the breadth of the work reported in the material referenced.

Front End Planning

Front end planning includes all activities in preparing a project to the point where the owner authorizes funding for complete design and construction. Front end planning generally involves the definition of the project from a concept or need by an operating group in a facility or a mandated project from a health or safety requirement through perhaps the first 10% to 30% of the design. The importance of the preliminary design is to be able to develop as accurate an estimate as possible and to identify major equipment requirements as early as possible. Harding (1997) suggested that the following be used for fast-track scope definition on small projects. The definition of “small” included all projects up to \$5MM.

- Small projects require additional resources to assist in scope definition as a percentage of the overall cost of a project (including a negotiated fee with an engineering firm)
- Management should relax the documentation requirements for funding requests and project approval. Delete non-essential documentation requirements.
- Process deliverables were described as a written scope document, piping and instrumentation diagrams, equipment arrangement drawings, project cost estimate, and schedule.
- Allow projects to have 15-20% contingency instead of usual 10%, but not an excuse for eventual shortcuts
- Start on permit applications as early as possible
- Project approvals – partial approval for some projects to perform design engineering and place long lead orders (be sure to include cancellation costs)

Malwitz (1986) contends that feasibility estimates can be no better than +/- 30%. In order to achieve this level of estimate between 10% and 20% of the capital cost is needed for developing and obtaining preliminary engineering plans, drawings, vendor quotations, and contractor bids.

Westney (1985) contributes something of interest to the decision making side of the small project front end planning process. The author encourages development of guideline for project decision making for each project on the relative importance of: 1) investment cost; 2) operating cost; 3) performance characteristics; and 4) start-up date. An example of a decision guideline would be; it is worth \$4000 in increased investment (cost) for each day that the start-up date is advanced. Westney also described project prioritization in the front end-planning phase briefly. Three primary questions were posed for evaluation.

1. To what extent is the project essential? (work scope priority)
2. Does it involve an essential system (operations) in the facility?
3. What is the financial attractiveness of the project? (return on investment)

Front end planning leads up to a approval for proceeding to design and procurement activities. However, Harding proposed the use of a checklist throughout the project process. The general outline of the checklist follows:

Scope

- Scope project requirements
- Develop P&IDs
- Prepare preliminary equipment arrangements

- Develop project cost estimate/budget
- Develop project schedule
- Complete Appropriation request documentation
- Start environmental permitting process (or other permits)

Approval

- Get management approval of the project
- Identify possible revisions to scope and budget

Design

- Bid/select engineering firm
- Specify process piping
- Specify auxiliary/utility equipment
- Specify instrumentation
- Specify control hardware
- Finalize P&IDs
- Finalize equipment arrangements
- Prepare drawings (civil, mechanical, architectural, steel, concrete, piping drawings, electrical power drawings, instrumentation and control wiring drawings)

Procurement

- Bid/Select (process equipment, auxiliary/utility equipment, instrumentation, control hardware)
- Approve vendor data
- Inspect/test at fabricator/manufacturer facility as needed
- Bid/Select (contractors – if multiple contractors needed)

Construction

- Authors list 16 activities that may or may not be appropriate to any one particular small project. This listing is not included here, but the list represents actual construction activities appropriate for developing a project schedule.

Commissioning and Startup

- For small projects typically shown as one line item
- Start-up may be one line item or specific individual activities
- Start on permit applications as early as possible

Design

Design, as suggested in the previous section, often starts before the project is ‘officially’ a project. With regard to the complete design, Harding (1997) suggests that an adequate design package is always crucial for ensuring smooth construction. Harding identified two main objectives to be accomplished in the design phase

- Identify and completely specify the long-lead equipment items. Complete vendor data will be needed in some cases to complete design (particularly dimensional data).
- Development of construction drawings so the construction can be phased.

Procurement

Harding (1997) proposed that a good practice is to not bid equipment for fast-track project but to select vendors and it is easier to justify if you have plant standards for equipment. No other direct reference to project procurement was found for small projects.

Construction

Harding (1997) suggests that if you have onsite construction forces be sure to schedule and prioritize the work process. If using a contractor selection process, the design may be phased if design will be released as work packages. Recognizing the importance in many plants for rapid project turn-around the traditional schedule compression activities of overtime and shift work are suggested for small projects.

Start-Up & Operations

Involving operators in the commissioning phase was the only reference made to this phase of the project. However, in many cases this may be necessary in the planning phase. Generally the concept of planning for start-up and operation of projects is ignored in the literature.

People

Table 2.3 provided an interesting perspective on the thinking style or traits of multiple project managers compared to others types of managers.

Table 2.3 Adaptors vs. Innovators (Tullett 1996)

High Adaptors	High Innovators
Are more concerned with improving the efficiency of the current system	Are more concerned with generating possibilities for a future system
Are characterized by precision, reliability, conformity, methodical ness, prudence	Are seen as undisciplined, thinking, tangentially, approaching tasks from unusual angles
Seek solutions to problems in tried and understood ways which are acceptable to most people	Resolve problems by redefining them, question basic assumptions and frequently offer novel solutions which are not immediately acceptable to most people
Produce a few relevant, safe ideas for immediate implementation	Produce many ideas including those seen as initially as irrelevant, unsound and risky
Prefer stable, structured, and predictable working environments	Prefer less structured and often changing working environments, easily bored with routine
Rarely challenge rules, maintain group stability and cohesion	Often challenge rules, are catalysts to settled groups, and so can be perceived as disruptive and abrasive

People tend to exhibit elements of both columns, so tendencies toward one or the other are used to create the overall characterization. Tullett hypothesized that managers of multiple projects would have a more innovative thinking style due to their need to work across multiple functional boundaries. The research evaluated responses from 203 multiple project managers and 559 managers in general. Managers in general average score was 97.9 and multiple project managers

scored 108.2. This indicated that the average manager of multiple projects is inclined to be more innovative in their thinking style. The innovative style of thinking is beneficial for many management responsibilities such as:

- Discussion of proposals with (potential) project sponsors
- Working relationship with project sponsors
- Assembling and leading project teams
- Planning and controlling projects
- Solving problems during different phases of projects

No other articles were found that effectively added to the understanding of people issues, except that they are a limited resource, on small projects.

Organization

Griffith and Headley(1995) note that two levels of organization exist. The first level is the organization of the overall small works management process and the second is the management of the individual small works. Many articles produced on management of small projects focus only on the individual small project and often from a small contractor perspective. However, this research focuses on small projects that are elements of a larger program often executed within alliance or partnered agreements. These concepts are not much different than large project alliances and partnering systems.

Project Processes

Will and Stewart (1991) highlight the relative improvements achieved in small project management. “Those principles and techniques known as project management have recently been applied to small oil and gas construction projects and the results have been observed in the efficiency with which such projects are completed.” They give a rather bleak image of the construction process for small projects prior to the use of the management techniques: design being completed as installation progressed, completion dates difficult to track or not tracked and lack of time control, costs were difficult to track and control – all were sacrificed in the interest of saving time. The economics of many industries have changed to demand more up-front planning for small projects and to introduce appropriate project controls. The breakdown for project development is a 5-step process:

1. Conceptual
2. Feasibility+/- 30% cost estimate phase
3. Detail Design +/- 10%
4. Material Procurement
5. Construction/Start-up

Work involved in detail design could account for 30-50% of the man-hours required for the total project. The author’s case study indicates they ‘leveraged’ their engineering staff by hiring a contractor to perform a portion of the detailed design. Periodic and frequent updates are needed during the design phase. In the case study all parties participated in design review.

Platje et. al. (1994) focus on the project and planning cycles for projects and portfolios of projects. **Portfolios** are described as a group of projects that have interdependent objective and use common resource pools (departments or expertise). A **program**, as defined by others in the article, was described as a set of projects that are managed in a coordinated way to deliver benefits, which would not be possible if the projects were managed independently. Portfolio

management can also be applied as a process where same personnel, within segments of a facility, usually execute the projects, although the projects are not necessarily packaged together,

The portfolio management team according to Platje and Seidel (consisting of project leaders and department heads) is jointly responsible for:

- Construction of feasible portfolios (satisfying the priorities of the projects within the boundaries set by management)
- The tradeoff (by negotiation) of (often conflicting) interests of the participants
- The communication between management, project leaders and department heads

The frequency of the portfolio planning cycle is a function of the stability in the portfolio content and process. When management frequently changes priorities, new projects are added or deleted regularly, or the individual project plans often change, and the portfolio content is subject to frequent variations. When individual project plans are mostly executed according to the plan, few bottlenecks will occur in the execution. When projects are frequently delayed or resource requirements change during the execution, more frequent portfolio planning is required to resolve bottlenecks.

Common Project Management Procedures

Payne and Turner (1999) list four advantages for a common management approach to all projects, regardless of type, size or resource requirements.

1. A consistent reporting mechanism can provide comparable progress reports across all projects
2. Resource requirements can be calculated consistently, facilitating management of capacity constraints
3. People can move between projects without having to relearn the management approach
4. Small projects can be used as a training ground for future managers of large projects.

In many small project environments, the non-homogeneous mix of projects lends additional complexity to the process. Payne and Turner conducted a survey that highlighted the fact that a common procedure for all projects, regardless of type, size and other factors does not improve the likelihood of success. Tailoring project management procedures to the size of a project does not reduce the chance of success; it probably increases it. Another way to view this is that applying the same procedures across all projects increases the risk of failure. They go on to evaluate several contributing factors that are summarized as:

- Small projects cannot bear the burden (bureaucracy) of procedures designed for larger projects
- In management of large projects emphasis is on the complex sequence of activities, balancing resources across activities within the control of the project. Major projects, although they could be viewed as multiple smaller projects, may represent a single failure capable of sinking the parent organization or severely damage the organization.

The solution proposed was to develop a strategic plan for every project based on a common approach that allows different approaches to the level of detail or tactical level. The three levels of planning are as follows:

Level 1 – Integrative A Project Definition Report will be developed for all projects, based on a common model. This will ensure all projects are defined in a

	common way, giving a common basis for comparison and prioritization
Level 2- Strategic	Develop Milestone Plan and Project Responsibility Chart for each project component. Enables consistent approach to assignment of resources and responsibilities and for tracking and comparing progress
Level 3 – Tactical	For small projects there may be no further level of planning. For engineering construction and building projects the lower levels will be developed in some detail at an early stage, based on known activities to be performed.

Project Controls

Griffith and Headley (1998) identify two levels of control necessary in small projects. The first level of control is at the overall small works management and the second is the individual project. This is an important point to differentiate for readers. Their research indicated that static control systems are often used for small projects. Static controls are based on procedural rules and regulations. However, due to the nature of small projects, static controls often fail to provide any measure of control because they are not sensitive to changes that affect small projects. Malwitz (1986) noted that in controlling costs for a small project, traditional accounting systems are too slow to react in time to exercise any form of cost control.

Contracting

Harding does not recommend single source EPC for retrofit projects. Due to the large number of interfaces needed, Harding claims you lose a little bit of control with this approach. The owner does gain a single point of responsibility and if an engineering constructor is procured with contract incentives, there may be a benefit from the practice. Griffith and Headley (1995) state that some organizations were outsourcing the small works procurement function to consultants. This was the only reference to this practice encountered in the literature review.

Project Success Factors

In addition to reviewing the literature for factors related to project execution, key project success factors presented another area for review. Previous research on project success factors was reviewed for both large and small projects. Since few authors specifically identified what size projects were involved in their work, the assumption was that these factors were developed from a wide range of projects and would be applicable to small and large projects. Much of the research was conducted in the early 1980's with a general resurgence in interest in the late 1990's into 2000. The literature review reveals how much has been accomplished in the area of measuring or evaluation of the success of a construction project. Since it is generally accepted that budget, schedule, and quality are the major concerns for a construction project, this section of the literature review was particularly interested in identifying the measurements and the critical factors or indicators. The measures and the indicators or the factors of project success have the general accepted meaning although they may change depending on who is making the evaluation, which phase of project is being evaluated, and what baseline values are being used to make the assessment.

Measures of Project Success

Many researchers have investigated the measurement of project success. Key findings from a wide range of articles are presented in a more or less chronological order. Some agreement exists among the researchers, but clearly there are many interpretations that can be applied to measures of success.

Murphy, Baker, Fisher (1974) measured success using six items:

1. All things considered, the project was a success,
2. Parent organization satisfaction,
3. Client organization satisfaction,
4. Ultimate user satisfaction,
5. Project team satisfaction, and
6. To what extent did end results fulfill technical performance or mission.

The authors further stated that measuring success is a multi-dimensional concept with several measures that are both objective and subjective in nature.

Cleland (1986) examines project success from the owner's viewpoint and states that success is meaningful only if considered (1) the degree to which the project's technical performance objective was attained on time and within budget, and (2) the contribution that the project made to the strategic mission of the enterprise. Measuring the success of a project includes an ongoing assessment of how the project is perceived by parties (project team members, subcontractors, suppliers, government agencies, customers, and other relevant groups). One party's view of a project success can differ from another party's view of success.

Anton de Wit (1986) pointed out that a project is considered an overall success if it meets the technical performance specification and/or mission to be performed, and if there is a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the project team, and key users or clientele of the project effort. Measuring success is complex and that a project is hardly ever a disaster or failure for all stakeholders during all phases in the life cycle. Therefore, a project can be a success for one party and a disaster for another. Success is also time dependent. A project may be perceived a Success one day and a failure the next.

Ashley et. al. (1987) investigated that success was defined as results much better than expected or normally observed in terms of cost, schedule, quality, safety, and participant satisfaction. The research showed that there were six criteria used to measure construction project success:

- Budget performance,
- Schedule performance,
- Client satisfaction,
- Functionality,
- Contractor satisfaction,
- Project manager / team satisfaction.

Sanvido et.al., (1992) stated that success for a given project participant is defined as the degree to which project goals and expectations are met. These goals and expectations may include technical, financial, educational, social, and professional aspects. These expectations may

be different for many project participants.

McCoy (1986) measured success using an integrated project baseline approach, which is established that success in the early phases of the project was due to monitoring project cost, schedule and technical performance.

Might and Fischer (1985) employed six distinct measures of success. These are:

- An overall subjective measure of success by the respondent,
- A measure of cost over/underrun as a percentage of the initial estimate,
- A measure of schedule over/underrun as a percentage of the initial estimate,
- A subjective assessment of the technical success relative to the initial plan,
- A subjective assessment of the technical success relative to other projects in the firm, and
- The subjective assessment of the technical success measured in terms of the technical problem identification process (i.e. a successful project is one that requires little or no crisis management while meeting cost and schedule goals).

Naoum (1994) used a theoretical framework to assist in comparing project performance and concluded that to achieve project success, the parties need to match the various organizational forms to the client's characteristics, criteria, and priorities with respect to time, cost, and quality. Naoum defined 10 factors to measure project performance as follows:

- Preconstruction time,
- Construction time,
- Total time,
- Speed of construction,
- Unit cost of building,
- Time overrun,
- Cost overrun,
- Client's satisfaction with time,
- Client's satisfaction with cost, and
- Client's satisfaction with quality.

A review of the literature shows that different researchers use different measures although these different measures often contain similar general concepts for project success. This portion of the review did not yield any construction-related articles using specific measures for small project success.

Factors Related to Success

Many articles have been written related to factors showing construction project successful. Murphy, Baker, and Fisher (1974) identify several determinants of project success. The study was designed to include as many variables as possible that are important for project effectiveness. Several individual variables were identified as strongly correlated to project success, which are:

- Project team sense of mission,
- Project team spirit,
- Project team goal commitment,
- Project team capability,

- Project manager's satisfaction with planning and control, and
- Unity between project manager and client contact.

Might (1985) also analyzed, in his research, that if project size is a factor affecting the utility of various project management systems by categorizing the projects into high and low cost grouping by which as much differentiation as possible was assured and the smallest and the largest dollar value projects could be directly compared. Projects costing \$2,000,000 or less were classified as small projects. Regression analysis, which had the six criteria of success as the dependent variables and the project management control techniques as independent variables, were run for the large and small project data, separately, and levels of statistical significance associated with the regression coefficients are presented. Might concluded that the analysis did not yield the dramatic distinctions between large and small projects that many observers would believe exist. However, the analysis suggested (1) that there might be, in fact, some differences between large and small projects with control systems, apparently having considerably more influence (both positive and negative) on project success in large projects than is the case with smaller projects, (2) that the use of technical monitoring as a project management control system stands out from among all of rest in the uniformly strongly negative association between its use and overall project success and that only large projects can afford tight technical control.

Jolivet and Batignolles (1986) identify a list of 17 simple criteria often found in successful construction projects that are nonexistent in unsuccessful projects. These success factors are:

- A project director is nominated,
- The project is subdivided,
- The project organization is determined by the project director,
- The objectives are established and made known,
- Activity is in accordance with written procedures,
- Contract management,
- Program management,
- Cost management,
- Quality management,
- Administrative and financial management,
- Personnel management,
- Design management,
- Purchasing and subcontract management,
- Construction management,
- Shutdown procedures,
- Management of project "know-how", and
- Documentation.

Sanvido et. al. (1992) stated that success on a project means that certain expectations for a given participant were met, whether owner, planner, engineer, contractor, or operator. The four most critical success factors derived from the Integrated Building Process Model are:

- A well-organized, cohesive facility team to manage, plan, design, construct, and operate the facility,
- A series of contracts that allows and encourages the various specialists to behave as a team without conflicts of interest and differing goals,

- Experience in the management, planning, design, construction, and operations of similar facilities, and
- Timely, valuable optimization information from the owner, user, designer, contractor, and operator in the planning and design phases of the facility.

Conley and Gregory (1999) developed a concept for partnering for small construction projects and stated that the reduction in schedule growth and claims cost along with the increase in value engineering savings support the use of partnering concepts in projects of all sizes and since small construction projects do not always have sufficient funding to enable them to organize a formal partnering effort, with paid facilitators, an informal partnering option is suggested. The use of informal partnering on small construction projects would be more appropriate for projects that have duration of at least 6 months and where schedule growth is a major concern of the owner.

Chua, Kog, and Loh (2000) distinguished the critical success factors for different project objectives of budget, schedule, and quality using the analytic hierarchy process. These researchers determined the relative importance of 67 success-related factors, which were grouped under four main aspects:

- Project characteristics,
- Contractual arrangements,
- Project participants, and
- Interactive process.

The top ten overall ranking factors are:

- Plans and specifications,
- Constructability,
- Project management commitment and involvement,
- Realistic obligations/clear objectives,
- Project management competency,
- Contractual motivation or incentive,
- Site inspections,
- Construction control meetings,
- Formal communication (construction), and
- Economic risks.

However, each set of critical success factors differs depending on the project objective. The top ten factors for budget performance are:

- Plans and specifications,
- Constructability,
- Economic risks,
- Realistic obligations or clear objectives,
- Project management competency,
- Funding,
- Budget update,
- Project management commitment and involvement,
- Contractual motivation or incentives, and
- Risk identification and allocation.

The top ten factors for schedule performance are:

- Plans and specifications,
- Constructability,
- Project management commitment and involvement,
- Project management competency,
- Contractual motivation or incentives,
- Realistic obligations or clear objectives,
- Schedule update,
- Construction control meetings,
- Capability of contractor key person, and
- Pioneering status.

The top ten factors for quality performance are:

- Plans and specifications,
- Constructability,
- Site inspections,
- Pm commitment and involvement,
- Realistic obligations or clear objectives,
- Pm competency,
- Construction control meetings,
- Formal communication (construction),
- Capability of contractor key person, and
- Contractual motivation or incentives, and design control meeting.

Cheng, Li, and Love (2000) established a partnering framework to identify the critical success factors which can improve the productivity and performance of construction projects. These factors are:

- Effective communication,
- Conflict resolution,
- Adequate resources,
- Management support,
- Mutual trust,
- Long-term commitment,
- Coordination, and creativity.

The review of the literature yielded few construction-related articles focusing on success factors focused on small project success. Some work has also been done on identifying models of the factors to predict success.

Models of Success

Murphy, Baker and Fisher (1974) developed a model for project success using regression techniques. A stepwise regression analysis showed that successful project outcomes are based on multiple factors rather than simply caused. More importantly the work shows that many of the important factors lie within the control of those managing the project. The seven determining factors on the Perceived Success of Project model are:

- Coordination and relations,
- Adequacy of project structure and control,
- Project uniqueness, importance and public exposure,

- Success criteria clarity and consensus,
- Competitive and budgetary pressure,
- Initial over optimism and conceptual difficulty, and
- Internal capabilities buildup.

Pinto and Slevin (1988) investigated modeling techniques to identify important success factors depending on the project phase. These researchers determined that the critical factors are not of equal and stable importance over the life of the project--different sets of these factors become more critical to project success at different phases in the project life cycle. Subjective data was collected from 418 respondents on a series of 72 questions covering the list of 14 success factors. A stepwise regression analysis was used to identify key factors for each phase of the project life cycle. The cycles used in the analysis were: (1) Conceptual, (2) Planning, (3) Execution, and (4) Termination.

Jaselskis and Ashley (1988) developed a predictive discrete choice model for achieving outstanding project performance which included better scheduling performance, and better budget performance by four categories: project manager, project team (PM education level, PM technical experience, PM subordinates), project team (team turnover), planning (constructability), and controls (budget updates, control meetings during construction, controls meeting during design, and control system cost).

Griffith (1999) designed and developed an index to measure the success of industrial project execution, which is comprised of four variables: budget achievement, schedule achievement, design capacity, and plant utilization. The Success Index Equation yields results ranging from 1 (completely failure) to 5 (complete success), which can be used to compare success of a wide range of projects with different budgets, schedules, and products. An index value of 3 or higher generally, but not always, indicates that met or exceeded all four of the success variable goals.

With the exception of Jaselskis (1988) the models are generally not predictive in character and serve to validate some of the same factors identified in the earlier section on project success factors.

Small Projects Definition

A consensus agreement on the definition of a small project is difficult to achieve. One view into defining small projects was explained by Griffith and Headley (1998) as follows:

1. Cost of administration expressed as a proportion of the work itself can be much greater than larger projects.
2. Complexity of a typical (building works environment) is much lower
3. Short duration (one to three months)
4. Limited quantities of materials and labor but may be specialist in nature
5. Uncertainty higher – often unspecified or tentatively specified
6. Use limited formal documentation
7. Some small works have considerable diversity in size, value and complexity and are procured and managed using formal systems
8. They typically occur in active environments – requiring minimal disruption and hazard exposure

The complexity factor as addressed above relates to the technology of the process. The authors were examining the small project process for building projects. Otherwise the description fits the character of projects evaluated in this research very well. The most significant element of the definition above is that no fixed dollar amount has been artificially attached to the definition. However, as stated in the objectives of the study small projects have adopted a cost cut-off definition.

Literature Review Conclusion

The approach to define small projects by Griffith and Headley is beneficial to describing the key differences of large and small projects. They also noted in their work that there is a growing realization among building owners and users that the controllable cost element (small capital projects) can represent an important ‘profit opportunity.’ “A more effective and efficient small works procurement policy represents one area of the controllable costs which can assist an organization in the drive to optimal use of the property estate.” This realization is the driving force for continuous improvement of small project management processes and procedures.

Struckenbruck (1986) pointed out that measuring success may be quite complex due to the many different perspectives of the project so that simply comparing a project's accomplishments with its planned goals and objectives can be deceptive. Each project party has very different criteria for project success, depending on how they measure success, what they are evaluating, and when the evaluation takes place. However, this review points out that the following are common elements of project success:

- Project time or schedule completion
- Financial success based on project cost or budget
- Customer satisfaction (varies depending on viewpoint)
- Project functionality (meets technical specification)

These can be achieved by:

- Effective formal and informal communications (clear objectives and obligations)
- Capability of project management (competency, commitment and involvement)
- Design and construction control meetings (scope control, schedule updates, budget updates)
- Performing constructability reviews
- Proper evaluation and allocation of risks
- Long term commitment and mutual trust
- Project checklists similar to that proposed by Harding

Chapter 3 Data Collection Summary

Survey Development

Data collection for the research project was designed for two stages. The first stage was to develop a general questionnaire to be distributed to small project managers. The research team was instrumental in developing a series of questions in all areas of project management that would have some significance to the execution of a valid fact finding questionnaire. A roster of the research team is provided in Appendix A. The preliminary questionnaire was then pilot tested by the members of the research team. The completion time ranged from two to three hours, but required the pilot test respondents to assume fairly gross estimates of some requested numerical data, since they did not have access to data sources when filling completing the questionnaire. However, after modifications from the pilot test, it was felt that the extensive survey was “on target” to capture the data the research team was interested in acquiring. A copy of the final survey is included in Appendix B of this report.

The CII benchmarking survey was reviewed in the development of the team’s questionnaire. However, many of the details of the benchmarking survey were not considered applicable to the information desired in the research.

Survey and Interview Process

Overall 36 surveys were entered into the project database. However, 43 interviews were conducted in collecting data summarized in the following chapter. The interviews were conducted at the respondent’s office location. However three interviews were conducted by telephone due to schedule difficulties or preference of the respondent. Some surveys represent an aggregate response from several persons within an organization who had small project responsibilities and they collaborated on responding to the document. Some interviews were conducted with organizations promising the survey at the time of the interview. However, these surveys were usually not returned. Additional contacts (voicemail and e-mail) generally did not result in return of the requested data. As a result, the response rate falls to as low as 12 responses for some questions. Primarily these were questions related to specific data requests. This was due to either a lack of desire to respond or the respondent’s organization did not track the requested information and, therefore, it was not easily obtainable.

Table 3.1 Survey and Interview Count

Content	No.	Notes
Initial Database	59	
No interview conducted	14	Conflicts: 6; Cancellations: 8
Survey Only (no interview)	2	Survey was returned but no interview scheduled due to schedule conflicts
Total Interviews Conducted	43	$59-14-2 = 43$
Interviews combined in surveys	9	Some interviews were combined to complete a single survey
Total Surveys Entered Into Database	36	$43-9 = 34$ surveys from interviews plus 2 surveys submitted without interviews

The roles in Table 3.2 represent the function of the person who responded to the survey. The Corporate line represents how they viewed the primary function of their company. In the following sections classifications are based on how the respondent viewed their role or function and not their corporate function. This is necessary to maintain consistency with a number of owner respondents who maintain an in-house design function. In some cases this was a limited function but some retain complete design staff for projects.

Table 3.2 Demographic Distribution of Surveys

Category	Function or Role		
	Owner	Engineering	Constructor
Respondent Role	13	17	6
Corporate Function	21	8	7

Survey Summary

The survey was organized using a preliminary draft of knowledge areas identified by the Construction Industry Institute. This organization provided a convenient mechanism for preparing the general survey and organizing the responses.

Front End Planning

1. Due to the short duration of most small projects how would you compare detailed planning efforts with those conducted for large projects?

The majority of respondents felt that small capital projects have less detailed planning effort than large projects by a 3:1 margin (n=33). Little detail was provided to support the positions taken.

2. Describe the logistics challenges that are different for small projects vs. large projects planning in your work environment. The position taken that less detailed planning is conducted for a small project is supported by respondent descriptions of the logistics challenges within individual work environments. The following list is a rank-order listing of the key logistics challenges provided for small projects.

- Shortened or compressed time frame for planning and executing project
- Reduced front-end planning, faster turn around for scope and concept
- Information flow and communication needs - same groups involved over a wider range of projects
- Project management infrastructure
- Less formal process overall
- Smaller and more flexible project team
- Less functional support from management vs. larger projects
- Resource sharing needed

Nearly all respondents feel that there are differences in project planning, but few differences exist in the deliverables from the planning process for small vs. large projects. The front end planning for owner organizations produces a funding authorization; either for the entire project, or depending on the number of authorization steps, at least an authorization to develop the final project documents would result from initial stages. Final project funding, depending on the owner, may be reserved for a final approval review and will often require that the small projects clear appropriate financial hurdle rates. Some owner organizations preferred a more streamlined approach to the process. They would authorize funding as soon as possible to include both design and construction costs. From engineering and contractor perspectives the process results in scope statements, preliminary schedules, preliminary estimates and feasibility design, if needed. Many small capital projects are in-kind replacements or upgrades of existing systems that require little engineering from the standpoint of original design. More information on this was obtained during the interview process and a discussion of the project process is provided in Chapter 4.

3. How is risk management handled differently for small projects when compared to large projects?

Risk management is not different in an overall context for small and large projects. However, a great deal of diversity exists in examining individual risk classifications. The questionnaire respondents were asked to rate risks as being the same or different for small vs. large projects. The number of responses varies within each question. Not all participants responded to all the categories.

Consider the following risk classifications. Is the risk that each represents the same or different for small capital projects compared to large capital projects?

Table 3.3 Risk Comparison Small vs. Large Projects

Risk Category	Same	Different	Key difference factors
Engineering	9	11	
Construction	13	7	
Procurement	11	10	More site based procurement
Performance	11	8	Better performance than large projects
Regulatory Requirements	16	9	
Health/Safety	18	1	
Economic	9	12	
Contractual	12	6	
Environment	17	3	
Political/public	9	10	
Other	-	-	None provided

Health/Safety and Environment categories were nearly unanimous for the risks being the same for large and small projects. In the case of health and safety the dissenting vote indicated the risk of death was highest for large projects. Engineering risk was thought to be somewhat higher by some due to the shortened turnover time from project inception to completion. Inadequate design time was considered to be a higher risk. This was balanced with general comments to the effect

that many of the projects did not involve highly original designs, mostly considerations for in-kind replacements. Construction differences were identified, as higher use of formal process audits for large projects. The deliverables were thought to be more easily defined for a small project. Others felt that construction risk was higher due to projects being more difficult to define and in some cases more difficult due to higher incident of actual site conditions varying from initial planning.

4. In project planning, a contingency is often included in budget and time estimates. Is there any difference in contingency for small projects?

The respondents were split on whether or not there is a difference. Fourteen of 31 respondents said they felt there was a difference. The differences were attributed to quick execution time frame with less up front planning time available. Thus, the reduced planning and engineering time in the project required higher contingency allocations.

Contingency allocations for small projects, where provided, were generally higher than contingencies for large projects. Small projects were often given 2 to 5% higher contingency allocations than large projects. The rationale provided for distributing more contingency on the smaller projects included the following:

- Less detail in engineering - more possibility for problems
- Small project errors or omissions are magnified when viewed on a percentage basis. A \$10K error on \$100K project is 10%, but only 0.1% for a \$10MM project
- Large projects can pool contingency and distribute where needed - small project pool allocations result in projects being cancelled when overruns occur.

One respondent very pointedly said their view of contingency was that it represents 'a reserve amount to finish the design once the project is released to construction.' This clearly highlights problems associated with the compressed time cycle discussed above in the front end planning process and design issues below.

5. Are specialized project checklists or expedited review processes used for small projects?

Specialized project checklists for the review process are widely used, 20 of 34 respondents to this question have or use specialized checklists. Of the 20 currently using some form of expedited checklists, only 7 were willing to share a copy of their forms. The checklists were often a condensed version of the information required for generating another formal document. The checklists were commonly viewed as reminder lists so major elements would not be forgotten in planning and executing a project. Although it would be beneficial to reproduce some of the checklists many of these documents were for limited distribution and the researcher did not have permission to reproduce them. A general description of the checklist contents can be provided.

Project Definition Checklists - a document developed to assure the project is meeting the requirements for developing the scope of the project. The project definition document developed from the checklist forms the basic reference for the scope of the work. Requires development of basic project objectives (customer defined requirements), schedule requirements, principal activities required, impact of activities on services or utilities, impact on existing operations and facilities, major equipment involved, and some estimate of the project's urgency or priority.

Project Definition Rating Index a Construction Industry Institute tool for measuring the degree of scope development on industrial projects. Permits the project team to rate the level of scope development on a project prior to requesting authorization of funding.

Business Case Checklists are outlines of primary sections needed (need is based on company specific requirements) for describing the basic need of the project. Some lists were geared toward identifying priority projects. Value added analysis, internal rate of return hurdle rates, payback periods, and other financial justifications outlined.

Engineering Cost Estimate Checklist asks a series of questions regarding issues that impact the engineering cost estimate and generally covers three main areas for each project discipline (mechanical, electrical, civil, and etc.) on existing site conditions, code issues, and coordination issues.

Project Delivery Strategy Guideline is not a checklist in a strict sense. It is more of a guideline or outline to a project summary document that describes scope, environmental, safety and health issues, schedule, design, commissioning and procurement requirements. In addition to these project related elements the guideline also describes considerations for resources, construction requirements, communications requirements, start-up and project close out.

Project Initiation Checklist is an expanded outline that concisely documents all the project details. General project information includes elements like client name, client representative, type of contract, date of authorization to proceed and other general data requirements. The scope of work is broken down into concise definitions including performance tests and guarantees. Other sections cover client approval requirements for various elements of the design, procurement and construction process, correspondence distribution, estimating and purchasing roles and responsibilities, general engineering and construction requirements to name some of the other sections.

Design

6. Is a construction representative involved during the design of the project?

The responses to the design section show that constructability, or at least construction representation, is widely used during the small project design process. 24 respondents use some form of constructability as opposed to 8 responses indicating that a construction representative or their input is not involved in the design phase.

7. What are the deliverables from the design process?

Design deliverables were consistent with large project design, although in a few cases it was acknowledged that more cases of sketches and arm waving were used initially in the design to assure the design moved as quickly as possible. Documentation of the constructed design often followed. The deliverables listed included: process safety data, isometrics, schematics, detail design, scope description, vendor data, equipment requirements, cost estimates and general responses for plans and specifications.

8. What is the frequency of scheduled project team meetings during the design phase?

Design meetings tend to occur on a weekly basis, with others reporting meetings as needed. In the interview portion of the data collection process, the majority had weekly meetings scheduled, and supplemented the weekly meetings with smaller meetings to supplement the weekly meeting. In many cases, other than project kick-off meetings, the weekly meetings were typically used to document design progress on all active projects, not just one project's design progress.

9. What productivity measurements are tracked for small projects?

Major productivity elements tracked for design productivity were as follow:

- Cost budget vs. actual costs
- Schedule planned vs. actual
- Man-hours budget vs. expended
- %Engineering of Total Installed Cost (%TIC)
- % Materials vs. Labor
- Hours/task
- # Work packages released on time, # projects complete on time
- % Home office overhead
- % Rework

Several respondents questioned the overall value of these traditional measurements when they are used and reported in the small project environment. They felt that many of these measurements had little significance to the task. Several respondents clearly indicated that no such measures were made or that they were of limited value. No benchmark performance factors were provided, but evidence of these factors were noted during interview sessions.

Procurement

The questions prepared for procurement drew a diverse group of responses.

10. Who performs Procurement?

Owners, engineers, and contractors all have procurement specialists. So, when examining who actually performs procurement, a statement that procurement responsibility would depend on project requirements commonly clarified the responses. The survey data supports a perspective where the engineers dominate procurement (process industry responses). The contractors commonly purchased bulk materials and consumable materials, but could be key members in procurement when the project conditions dictated.

11. Who typically performs expediting?

The expediting role is commonly a follow-on assignment to those involved in procurement. Engineers again dominated the responses, but the pattern of responses was split fairly evenly between the owner, engineering (design organization), and constructors. Sixteen responses had multiple parties performing this function. The owner and engineer were most dominant in the alliance and multiple party responses. Eighteen responses showed single source responsibility. The engineers were the majority of these responses.

12. Whose paper is used for procurement?

This question was looking at a practice of using the owner's purchasing systems to purchase materials for construction. It is recognized that equipment items are often ordered by the owner ahead of construction and would most likely be purchased using their internal system. In other cases, because of preferred vendor arrangements, the constructors will order through the owner's system to take advantage of pricing agreements or delivery arrangements through the owner's receiving system. Twenty owner systems were used for purchasing, seven engineer's systems were used and only three constructor systems were used. Five reported all three were involved in purchasing. The interview portion will attempt to clarify when or where alternative arrangements for purchasing are used.

13. How is the vendor selection process different for small projects compared to large projects?

When existing equipment is being changed out it was a common response for the owner to select the vendor prior to final design. The equipment would be released to construction once a contract was in place to permit the contractor to expedite equipment deliveries. In other time constrained situations, the owner and designer would often be involved in equipment or vendor selection and expediting process.

14. Do you use a bidding process for equipment supply?

More than half of the respondents indicated that procurement practices on small projects were the same or very similar to large project procurement practices. Preferred vendors, supplier alliances and compatibility with existing systems were indicated as practices somewhat unlike large projects. Compatibility requirements were important where maintenance personnel have been trained with specific equipment and hardware. Compatibility also considers existing supplies of parts and spares. Plant standards often play an important role in this consideration. A cost related observation was reported in discussion of the procurement process. Discounts were typically less for small project procurement than for larger projects. With more reliance on known suppliers, several respondents remarked that there is less of a competitive environment. Bidding per se among a group of potential equipment suppliers is reduced due to existing standards and plant considerations.

Specifications for procurement were predominately detailed specifications. Functional specifications were listed with detailed specifications in almost half of the cases. The least selected type of specification was the design-build specification. The discussion supporting these choices was that small capital projects often required less or a lower level effort for design.

15. Are small project deliverables such as spares, training, and documentation included with equipment?

Yes (23 of 31) documentation is a key deliverable. Spares and training were not supported as much. Spares were likely available in existing supplies for many standard equipment items and training was not needed in many cases do to familiarity with the equipment.

16. For small projects, what are the key deliverables in equipment contracts to ensure functional, timely and lowest cost equipment?

Key deliverables (requirements) in equipment contracts to ensure functional, timely, and lowest cost equipment could be grouped into two areas:

- Plant standards limiting the choice to known product and performance, stay with existing vendors - fewer problems
- Specifications and vendor or shop drawings
- Drawing approvals

17. Do equipment vendors' delivery schedules for small projects require site visits, factor acceptance tests, or restrictive payment schedules?

Only one respondent suggested that on-site inspections were important to the process. However, most did perform inspections, particularly for items critical to the schedule or the process. Most however would perform site visits in the same manner for large projects. A key difference noted in regard to the inspections themselves was that they are often end-of-fabrication inspections rather than staged or step inspections during the fabrication. Several respondents indicated they limited vendor inspections to large projects.

18. For small projects, which project team members are included in the review of the equipment vendor bids, contracts or negotiations?

Most of the respondents used a multiple party or team approval/selection review process. Some of the differences may be due to semantics for titles:

- Design specialists (9)
- Project manager (7)
- Project engineer (7)
- Purchasing (3)
- Lead discipline engineer (2)
- Operations and maintenance were noted in a few surveys (2)

Most of the teams included both project managers or engineers and the design specialists or lead designers. A single person did not usually perform vendor selection.

For equipment selection, 50% of the respondents indicated there was no difference in the procurement process. The remaining responses suggested two differences in the process:

- More use of standing preferred vendor agreements established by plant procurement
- Process is oriented toward choices that are compatible with existing equipment (not always the most cost effective choices for the equipment but considering spare parts, training etc, often is the most logical choice).

Government procurement regulation limits procurement activities by project managers. Contracting officers are the front line contact for contract relations and all contracts are procured on a competitive basis. Design contracts can be procured under indefinite delivery contracts where specific projects can be amended to the base contract without a competitive bid.

Construction

19. During execution of the work, is there an owner's representative on site?

The responses to this question suggest a more narrow definition might have been needed. Fourteen reported a part-time owner's representative on site, fifteen reported a full-time representative, and two reported that the owner's representative was not on site. The interview process will be used to clarify responses to this question.

20. Does and in-house workforce complete small capital projects? What type of workforce is typical for small projects? What type of workforce is typical for large projects?

In-house workforce capability was limited to a few organizations where the plant workforce is unionized and construction craft representation is present within their maintenance organization. In all, 10 respondents indicated they had a union environment and 16 responded as either merit shop or non-union. Several of the union environment organizations had a contracts review committee to determine if the in-plant union forces would perform small capital projects work or if the work would be contracted out. For large capital projects the tendency leaned toward non-union and merit shop more heavily (17) than union (7).

21. How is change managed for small projects?

Changes are a prevalent element in the fast track environment of small capital projects. Effective management techniques are important to budget control. No unique or specialized processes were identified. Many respondents indicated that they used the same procedures for all projects.

22. What productivity measurements do you track for small projects?

Productivity measures were very diverse among the respondents (numbers in brackets indicate the number of responses for each category):

- Milestones achieved (schedule) (5)
- Cost of quality and rework costs (4)
- Work hour expended vs. budgeted (4)
- Total cost (4)
- Unit rates (productivity) (3)
- Unit rates (total cost) (2)
- Progress payment review process (2)
- Customer satisfaction (2)
- % time spent constructing (work sampling)
- Safety
- Engineering and home office expense %
- Installed quantities
- Earned value

Cost and schedule, traditional measures of work effectiveness, remain the more popular measurement techniques for productivity on projects and were tracked by all organizations. Tracking rework costs places a focus on how well the front-end processes were accomplished as well as the contractor's effectiveness in executing the specifications. Productivity rates, work sampling, and installed quantities were primarily of interest to contractors.

23. What is the frequency of scheduled project meetings during construction?

Coordination meetings during construction were predominately weekly. Since most contractors and owners were engaged in multiple projects, weekly meetings were felt to be the most effective process to exchange data and provide an update on progress status for all the projects. Although weekly meetings was the predominate method, a significant number of the responses included comments that supplemental meetings were held as often as daily for some projects. Additionally, one respondent provided this insight to the importance of having effective meetings to transfer information:

"Typical project durations are less than three months. A normal range for the actual execution time would be in a range of 6 to 8 weeks. Project reviews once each week may not be adequate for all cases. Emergency projects were not included in the study, but these do occur and the meetings are nearly continuous over the span of the emergency and the emergency project must be inserted on top of the existing project workload. In some cases a cycle occurs where meetings are weekly, up to the point in time where daily meetings are needed to ensure proper completion, then back to weekly until the next project deadline is challenged."

No specific pattern of meetings for project progress was noted in the responses. Monthly status reports tended to be an overall program of projects review, which would include design, while weekly meetings were more specific to progressing the work under construction.

24. How is production downtime planned for small projects?

Much of the influence on meetings in the previous paragraph is the result of a primary difference between small capital projects and large capital projects. On large projects there is one single schedule with multiple elements coordinated to the one completion event and everything is coordinate to that date. In small projects the project team must address the operating facility needs and modify construction planning to address their requirements so there are multiple completion events dictated by various needs and constraints. All of the small projects in the process industry environment are subject to schedules driven by plant outages or turnarounds that have fluctuating schedules. In effect, when a project occurs is a decision by production or plant operations personnel not the construction team per se. Even in many public-contracting situations, work schedules are modified to address owner demands. For example: construction projects may need to work evenings to not disturb the normal events and activities in a courtroom.

25. Do the contractors for small projects also perform maintenance work at the same location or plant? Do they maintain separate workforces for small capital projects and maintenance work? Do they track project and maintenance work separately?

In 24 responses the contractors were performing maintenance work along with small capital projects. In other instances, the contractors were aiding the owner by scheduling maintenance in conjunction with or in addition to small capital projects. The contractors who perform both functions do not typically maintain separate workforces, and in fact use the combined maintenance - small capital programs to help them level their workforce requirements. Due to financial reporting requirements, owners do require this work to be tracked separately. Contractors on the other hand do not need to maintain separate records, unless they are interested

in performing cost control functions on more than a total cost basis. Since many of these contracts were established as reimbursable contracts, assigning maintenance and small capital work to the same contractor was viewed as cost effective for both parties.

Start-up and Operations

26. Who prepares the master plan for commissioning projects? How is this different from large projects?

Master planning for commissioning is unlike major project where stand-alone teams are often created to ensure proper commissioning and start-up. In small capital projects there is much less formality, and in some cases the respondents' felt that the informality reduced the level of effective documentation. Small capital project start-up plans are often perfunctory because the plant operations personnel are often familiar with the equipment and systems purchased and existing documentation will support them adequately.

27. Who prepares and executes small project commissioning documents?

Small project commissioning documents, when prepared, are generally prepared by the owner or some element within the owner's team. Responses to responsibility for preparing commissioning documents included operations personnel (or owner) (15), owner's project engineer or operations engineer (4), engineer or designer (4), contractor (1) and commissioning group (1). The primary difference noted was that for small projects the documentation was less formal. The majority of the responses indicated there were not many differences

28. Who owns the documents?

Document ownership belonged to the plant or the owner, depending on the response and this was also consistent with large projects. Again, except for the volume of work, no differences were noted.

29. Describe how small project closeout procedures are different from large projects.

Primary difference for the project closeout process was that there is significantly less paperwork for an individual small capital project as compared to a single large project. Otherwise no significant differences noted.

People

Selection of personnel for staffing small projects also generated a variety of responses and comments in the survey.

30. Please describe how staffing decisions are made for small projects from design through construction for your organization.

Staffing decisions in many regards follows traditional selection concepts of expertise (Skill) and availability being more or less co-requisites to selection for project staffing. In this respect there is no difference between large and small project staffing. Availability is actually two distinctly different questions; 1) are they available for the site location and 2) if they are already on site, does their workload permit adding an additional project?

Owner representatives have the additional requirement or expectation that they have a reasonable amount of experience within the plant or in similar process facilities. When considering replacements for owner personnel, many responded they would be looking at engineering alliance personnel or in some cases contractor personnel they have on site as a possible source of future plant representatives.

Designers also look at expertise and availability as the primary selection criteria. Their main difficulty is in obtaining the wide variation of skills needed to execute projects in the small capital projects environment where workload swings between design disciplines can be significant in a short time period. They cannot maintain a full service staff on side, so they often rely on a pool of available talent in the home office to fill in gaps for design on a project temporary basis. Staffing from a pool of talent is advantageous where the project manager can identify those with better skills for small projects. An important attribute noted was selection of designers who enjoyed having more decision-making capability.

Depending on the project location, availability of temporary engineering assistance is an issue. In some areas of the country unemployment rates are very low and temporary engineering personnel are difficult to obtain. In other areas, if the industrial base is not growing, there is a supply of skilled designers available for use at short notice. This situation can change rapidly depending on owner decisions to upgrade or expand plants – creating a longer-term large project assignment. Therefore, geographic location and industry specific economics are elements somewhat peculiar to designer availability. One response indicated that the task was to use the minimum skill rate necessary to competently perform the work. A matrix formulation for site design services was fairly common within the design group. Any one designer could be working for several project engineers responsible for different areas of a plant.

Contractors face similar choices. However, since many contractors provide additional site services on maintenance contracts or large capital projects, their ability to level resource requirements may not be as severe compared to those whose primary site exposure is small capital projects alone.

Owners are acutely aware, in most cases, of the problems facing their design firms and constructors. In some cases they are willing to provide a minimum funding level to ‘buy out’ or support a minimum core team of designers on site at all times.

31. What is your ratio of project staff to project TIC (#staff personnel/\$1,000,000)

The ratio of project staff to project TIC drew a wide range of responses, several of which appear to have included trades in addition to supervisory staff. The follow-up question on ratio of supervision to labor hours provides a clearer indication of the management difficulties in small project.

32. Please provide an estimate of the ratio of supervision work hours to labor hours.

After removal of several outliers, the average supervision to labor percentage on small projects was 15.8% (n=14) and for large projects 12.25% (n=14) which suggests that nearly 30% more supervision is required on small projects. The number of responses to the numerical portion of this question was quite small which reduces some of the statistical reliability of the response, but many interviewees would not provide additional data when requested.

33. What steps are taken to integrate small project teams? What percent of small projects have formal team building planned?

Team integration at sites with long-term relationships among the parties was almost uniformly answered from "none" to "very little required," since the working relationships have already been worked out. In newly forming relationships the integration of the team had higher priority and more formal team-building activities. In public sector responses one internal view was that within the agency, no integration was needed since their transition from functional organization to a team based system. In another response, integration was a contractor's issue, not the owner's. Those that did report some form of team integration activity; the percentage of contracts ran from 100% to 3%. The 100% response was based on formal kick-off meetings for all projects. A general interpretation of the written responses would suggest that integration of project teams is a low priority on active long-term contracts and not issue that generates a great amount of support.

34. Is the team-building process different for small project teams?

With respect to teambuilding activities 17 of 22 respondents to this question indicated they have some form of team building activities on their projects. The differences between small and large project teams were noted as follows:

- Small project teams tend to stay together. Small projects are a nearly continuous stream of projects where large projects disband once the project is completed and move on to the next major project.
- Work together to build relationships vs. large projects that have organized team building activities
- Small project teams work on a continuous stream of projects, no project start-stop, and have better exposure to each other in a wide variety of situations

In evaluating if team building is as important for small project teams as it is for large project teams; 19 respondents felt it was as important and only 4 did not

35. Do you have specific qualification criteria for small project team leadership?

Specific small team leadership criteria were limited. Only 4 out of 19 respondents to this question indicated there were specific criteria. Commentary to this question yielded the following points:

- Must be able to walk on water
- Must have a multidiscipline background
- Experience with small projects important
- Knowledge of an operations area important (owner)
- Must be more organized and be able to start/stop projects at a moment's notice
- Deals with people a lot more
- Must be detail oriented

36. Do you maintain a separate incentive structure for personnel on small projects?

There were a few contract-based incentives reported where the design organization or construction organization could achieve a bonus, but no other personnel incentives for small project work were reported.

37. Do small project personnel have a career path with opportunities similar to other project managers?

Career path availability similar to other project managers was affirmed by 19 of 29 respondents to this question. Clearly the contractors were most likely to have successful career paths from small projects. Several comments to support their position was that they were measured more on performance and provided they performed well, promotions and salary increases were likely. In contrast, only 7 of the 12 responding engineering firms felt a career path was possible in the small projects arena. This was fairly close to the 6 of 10 positive responses from owner organizations.

38. Do you use personality profile or other standardized testing for identifying characteristics needed for small project management?

Standardized testing or personality profiling of small project managers was only conducted or reported by four of the 29 respondents to this question.

39. Do you maintain a skills database for all personnel to make staffing decisions?

Some form of a skills database was maintained for staffing decisions in 13 of 31 responses. The skills usually captured past experiences of employees. Twelve of the thirteen indicated the same database was used for large and small project staffing. One interesting comment written in the response for this question suggested that better talent was selected from the small projects list for staffing larger projects.

40. Has cross training been used to cover possible expertise gaps in small projects staffing requirements?

Cross training was evident in 20 of 27 responses. The general perspective was that it increased overall ownership in the final product and processes. In a similar opinion, one respondent highlighted the fact that some cross training improved communication and enabled people to have a wider perspective. In design firms cross training was interpreted as technical cross training. For example, cross training could be a civil engineer performing rudimentary piping design or a mechanical designing thrust blocks and other foundation elements.

41. Where would you envision the most benefit would be gained from cross training?

Responses were received from 22 survey respondents to this question. They essentially fall into four main areas of benefit as follows:

- Project ownership increases
- Increased flexibility with personnel
- Fewer staff specialists required
- Improved communication

The areas felt most promising for cross training were noted as some engineering disciplines, project management, and most often, procurement.

42. What is your estimated annual corporate turnover rate for small project personnel?

Turnover rates varied highly among the respondents. Numerically turnover ranged from 0% upwards to 50%. Contractors reported higher rates simply due to inclusion of field personnel

where demands vary during the course of execution. The majority of the responses centered between 10 and 15% annual turnover. This is somewhat contrary to the team integration and teambuilding responses that suggested less of these activities were needed due to long standing work experiences.

43. Is the system of incentives or rewards offered to small project personnel different than those offered to personnel assigned to large projects?

Reward systems for small projects were not different for the contractors who responded to the survey question. The negative comments made for this section were primarily from owner and engineer firms.

- Large project personnel get more recognition and promotions (1)
- Fewer rewards for small project personnel (5)

Organization

44. Do you have a separate organizational structure for small and large projects?

Sixteen organizations responded (of 29 total responses) that they had a separate organization for small projects. Major projects were viewed as setting up their own organization and small projects were independent from that process. Constructors tended to more consistently respond that they used a separate organizational structure. Several owners had established teams within their organization to handle small projects programming separate from maintenance.

45. How long have you had the current organizational structure for small projects?

28 respondents provided the following information on organizational structure.

Table 3.4 Organizational Structure Longevity

<1 year	1-5 years	5-10 years	> 10 years
2	11	5	10

46. Describe the organization used for small projects.

Most of the organizational formats reported were matrix organizations either as complete matrices or team matrices. Teamed approaches distributed work to teams that were established from available site personnel.

47. Do you maintain a permanent 'core management group' for small projects?

The concept of maintaining a core management group for a project was in effect for 17 of 29 responses in this category.

48. For contractors only. Do you maintain separate office facilities for small projects personnel?

All but one had a separate facility for these groups to work within. For contractors it depended on their total exposure with the owner. Some maintained separate offices where they could economically make it feasible to do so. Otherwise they operated more from a central office and management personnel reported to site when necessary.

49. Do you have a permanent workforce that participates in small projects?

Twenty one responses indicated they used a permanent workforce for small projects. They were able to maintain continuity using four basic concepts:

- Integrate maintenance work (increased workload or more consistent)
- Integrate larger capital projects (supports main workforce component, supplement for smaller work)
- Maintain a steady work load from the owner organization
- Employ local people who are more interested in staying at the project site

50. Do you try to mix experienced personnel with 'youth' on small projects?

Integrate new or younger personnel with more experienced personnel was practiced by 20 of 22 respondents. This process reduced the amount of formal training required. Using small projects to 'mold' inexperienced personnel was noted in one response. In another the response suggested this was more common on small projects than in general situations for engineers.

Project Processes

51. At which process stages do you authorize funding for small projects? What deliverables are available for each funding stage?

Project approvals follow a wide range of processes from owners. Essentially three to five step processes were described in the responses. The initial step would be development of the business case. Some funding needs to be allocated to generate the business case documentation. The feasibility stage requires engineering input and evaluation and authorization of funding to cover preliminary engineering costs. The final approval covers the cost of engineering and, in most cases, the authorization for expending construction monies. Many variations can exist on these steps.

52. Is there a management review committee for project funding?

Management review committees were reported for all owners in the study. Engineers also responded to this query since they are highly involved in the most of the capital project approval processes. In alliance projects where the engineering firm has been fully integrated, their participation is integrated through the owner's contract management.

53. Do you manage small projects as individual projects or as a program of work?

Projects budgets were typically fiscal year budgets without carryover. Money not spent on a project that would carry over into another fiscal year would be charged in the current year rather than permitting the budget process to carry funds forward. Therefore, most projects are managed independently. They are programmed as a group by various priority processes.

54. Do you have written standard process for small projects?

Two thirds (20) of the respondent firms had standard written work processes for small projects (n=30). Ten responding organizations report not having small project written processes, however they may have general processes for all projects. This question was specific to small projects.

55. Do you provide training to support the process requirements?

Some form of training is available to support process requirements in 20 of 27 respondent organizations. Both written small project standard processes and support training were reported in 17 respondent surveys. Only two reported written processes above that did not provide training. On the other hand four did not have written processes for small projects but did provide some form of training for their processes

56. If you use a single set of procedures for all projects, are they modified for small projects?

Nearly all of the processes were modified in some form to accommodate small projects. 15 out of the 26 respondents modified processes for their small projects. Most of the modifications involved paperwork reporting requirements accomplished by evaluating the standard processes to identify what applied to small capital programs. These modifications include evaluation of project checklists and similar process standard elements.

57. Do you ever out-source project management of small projects?

Only eight of the 28 respondents to this question have used out-sourced project management for small projects. The comments indicated that out-sourcing was limited to peak conditions or overloads when internal staff could not maintain workload.

58. Have you 'activated' retired personnel for managing small projects?

Unless workloads exceed personnel capabilities, few projects are outsourced for management. Fewer firms practiced retiree 'activation' for projects. Activating retired project managers to work sensitive areas (security or proprietary production areas) within the production facility was provided by one respondent as an example of where they would hire a retiree back into the field.

Project Controls

59. How do you handle small project change control?

Small project change control is not unlike that for larger projects variance reporting, change order logs, change tracking systems all seem to mirror general project control systems. Special change controls systems for small projects were reported for 11 out of 24 responses. However, detailed examination of the special systems suggests these are generally the same processes used for large projects with some minor revisions to reporting fields.

60. Do you use any special project control systems for small projects?

Special project controls were reported by 11 of 29 respondents to this survey question. Several report using internal or proprietary computerized project tracking systems, which were designed or tailored for small projects. In some cases the tracking is a simple list management on a spreadsheet system while others have been developing integrated packages that track project forms, estimates, and progress from start to finish. Labor analysis reports, project tracking (status) systems, and integrated cost and estimating systems were identified as being used on small projects.

61. For project completed in the last 12 months provide the average time from initial project idea until a) funding approval and b) mechanical completion.

Excluding public or government contracts yields a general range of 60 to 180 days for project funding approval, with many responses in the 90-day range. The time to mechanical completion was similar in the 360 to 180 day range. The ranges varied among various respondent groups, but the general completion averages by industry are similar, except for the government entities.

- Consumer Products – 250 days
- Heavy Industries (Steel production, ore refining) 210 days
- Pharmaceutical – 270 days
- Chemical and Petrochemical – 210 days
- Government – 850 days

62. For the small projects completed in the past 12 months, what percent of them were above or below the original funding budget? Do you track the source of the over/under runs when they occur?

One in eight engineers responded with budgets that exceeded budget more than 10% of the time. Five of five responding constructors had projects that exceeding budget more than 10% of the time. Six of eight owners had budgets exceeding their estimated budgets more than 10% of the time. The owners (n=9) reported 75% of their projects completed under a 5% overrun limit, constructors (n=5) reported 80% of their projects and engineering (n=10) reported 88% in the same range. Only seven organizations of the 24 respondents to the survey question reported a tracking mechanism to identify a source of problems with cost overruns.

63. For the small projects completed in the past 12 months, what percent were mechanically complete ahead or behind the original funding approval schedule? Do you track sources of the schedule variances when they occur?

Five of eight owners report scheduled mechanical completion greater than 7 days late 10% or more of the time. Four of nine engineers report scheduled completion greater than 7 days late 10% or more of the time and three of four responding contractors reported completion greater than 7 days late 10% or more of the time. As was the case with budgets, only seven organizations reported having a tracking method for schedule variances.

64. For projects completed in the past 12 months, provide the average cost as a %TIC for a) Engineering, procurement, management and administration, b) construction labor, and c) equipment and material costs.

Analysis of the average responses shows a wider variation of responses than expected. The %TIC reported for engineering procurement, management and administration labor varied from 30% to as low as 5%. It did not appear that %TIC data was accurately tracked for most projects. Once averaged for all data reported percentages showed little variation. For home office costs large projects reported 18% and for small projects 18%. Construction labor also averaged out to 35% for small projects and 31% for large projects. Equipment was reported as 41% on small project and 46% of large project TIC. Overall there is no significance differences in the average values.

Contracting

65. When do you use reimbursable contracts?

Reimbursable contracts were used in 27 of 29 respondents in the project. The reasons for using reimbursable contracts was attributed to poor scope definition by 9 of the 27 respondents in the questionnaire. Several indicated that was the negotiated contract type and it expedites the process. Few exclusively use reimbursable contracts.

66. When do you use hard dollar contracts for small projects?

From the survey, 21 of 27 responded that they performed small projects on a hard dollar basis. Three indicated this was their standard execution method while most others used for well-defined scope of work situations, like specialized equipment and when time was available to fully develop designs. The most unusual response was that hard dollar contracts were used when tight budgets were involved.

67. For engineering design on small projects, do you use: a) in house design or b) external design? What influences your choice?

In house design was typically conducted by those organizations who felt they still achieved the efficiency necessary for their production requirements or due to sensitivity of the process would not allow external design access. Twelve of 26 responses indicated design was conducted internally. Fourteen of the 26 responded with external design with the only comment that external was used due to alliance agreements. Six respondents in the 26 are double counted since they responded that they did both internal and external design.

68. Do you contract for construction management services on small projects?

Nine of 27 respondents replied they contracted for construction management services for some work. Generally the occasion to contract was due to increased workload and availability of personnel on site

69. Do you have owner-engineering contract alliances for: large capital projects? Small capital projects?

7 (of 11) owners for large projects and 9 (of 12) for small projects reported use of alliance contract arrangements for engineering contracts. 8 (of 11) engineers reported alliances for large projects and 9 (of 11) reported small contract alliances for design.

70. Do you have owner-constructor alliances for: large capital projects? Small capital projects?

7 (of 11) owners reported using owner-contractor alliance agreements for large projects and 9 (of 11) for small contracts. Only three contractors completed this section of the questionnaire and 2 (of 3) reported alliance agreements for large and small contracts.

71. When do you elect to use alliance partnerships vs. traditional contracting practices for small projects?

Alliance contracts are usually executed whenever possible. The alliance partner specialty or expertise on proven technology areas is important to the selection of the alliance partner. Many

responses simply stated they used alliances all the time. The original alliances existed for taking advantage of services and expertise. In some cases the alliance agreements are more cost effective for project execution.

72. Do you use vendor alliances for small projects?

Vendor alliances are used for reasons similar to alliances with service providers. From the survey results 25 of 28 use vendor alliances for small projects

73. Do you use a single prime contractor or multiple-prime contractors for small projects? Which is the preferred approach and why is it preferred?

The most favored method of contracting is with single prime contractors rather than multiple prime contractors. The advantage is a single point of responsibility. One constructor reported a preference for multiple-prime and two owners reported multi-prime preference.

Safety Health and Environment

One of the major sections in SP13 was health, safety and environment with a view that health and safety requirements were often relaxed for small projects. Table 3.5 summarizes responses to the questionnaire section on safety.

Table 3.5 Safety and Health Question Responses

Question	YES	NO
74. In your experience, are safety and health requirements relaxed on small projects?	3	27
75. Do projects have written site-specific safety plans?	27	5
76. Do projects have written site-specific emergency plans?	27	4
77. Do small projects use a site safety supervisor?	28	4
78. Do you use a written safety incentive program for hourly craft workers on small projects?	12	19
79. Are toolbox safety meetings required on small projects?	28	4
80. Is pre-hire substance abuse testing required?	29	3
81. Are small project personnel randomly screened for alcohol and drugs?	22	10

82. What was the OSHA safety records on projects for the past year?

Table 3.6 Small project Incident and Recordable Rates

	Incident Rate		Recordable Rate	
	Min	Maximum	Minimum	Maximum
Owner(6)	0	1.17	0	5.00
Engineering (5)	0	0.40	0	3.46
Constructor (5)	0	0.20	0	4.60

Table 3.7 Large project Incident and Recordable Rates

	Incident Rate		Recordable Rate	
	Min	Maximum	Minimum	Maximum
Owner	0	1.17	0	0
Engineering	0	0.3	0	0.8
Constructor	0	1.25	0	1.25

The data is inconclusive due to a low response rate. However, the pattern would suggest that the Recordable rates are higher on small projects. Since there is little back-up information speculation on causes for the differences is inappropriate.

Technology and Information Systems

83. In general, do you use automated project controls for: a) project scheduling, b) Project budget control or c) project productivity tracking?

Table 3.8 compares three major areas of project controls and the use of automation to assist in the process. For project scheduling fewer projects were using software to schedule projects or they were just beginning to apply scheduling to their small project programs.

Table 3.8 Automated Controls

Control Activity	Project Type			
	Automated Tracking on Large Projects		Automated Tracking on Small Projects	
	Yes	No	Yes	No
Project Scheduling	27	0	23	6
Budget Control	27	0	23	3
Productivity	20	4	12	15

84. What new tools or technologies have you found to be most effective for small projects?

The new tools or technologies most effective for small projects drew a wide range of responses. Consistent with the automated tracking question above scheduling software and budget software were the most popular.

- Scheduling software (11)
- Automated budget systems (3)
- Digital cameras (3)
- Integrated software (MSOffice, Lotus Notes) (5)
- Cell phones and radios (2)
- Website
- Email
- Bar coding
- Lessons learned files