CHARACTERISTICS OF SUCCESSFUL MEGAPROJECTS

Committee to Assess the Policies and Practices of the Department of Energy to Design, Manage, and Procure Environmental Restoration, Waste Management, and Other Construction Projects

Board on Infrastructure and the Constructed Environment

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Committee to Assess the Policies and Practices of the Department of Energy to Design, Manage, and Procure Environmental Restoration, Waste Management, and Other Construction Projects

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* This roster represents the composition of the Board on Infrastructure and the Constructed Environment when the original study on which this excerpt is based was undertaken.

Preface

The 105th Congressional Committee of Conference on Energy and Water Resources directed the U.S. Department of Energy (DOE) to undertake a review and assessment of its overall management structure and processes for identifying, managing, designing and constructing facilities (House Report 105-271). The language directed that this review be done by an impartial, independent organization with expertise in the evaluation of government management and administrative functions. Consequently, DOE requested that the National Research Council (NRC) conduct a study to review the policies, procedures, and practices used by DOE to identify, plan, design, and manage its portfolio of projects. The goal of the study was to develop recommendations to improve DOE's oversight and management of projects.

A committee formed under the auspices of the NRC's Board on Infrastructure and the Constructed Environment was chartered to review and assess the procurement and management of DOE's major construction projects, as well as its environmental restoration and waste management projects. The Committee to Assess the Policies and Practices of the Department of Energy to Design, Manage, and Procure Environmental Restoration, Waste Management, and Other Construction Projects comprised 13 experts with backgrounds in project management, contracting, budgeting and estimating costs; environmental remediation and waste management; civil, environmental, and nuclear engineering; government management and administration; and systems and performance analysis. The committee had extensive collective experience with DOE policies, procedures, and practices for identifying project requirements, developing scopes of work, executing and managing design, preparing cost estimates and schedules, selecting contract types, and executing and managing environmental restoration, waste management, and construction projects. The committee's final report, *Improving Project Management in the Department of Energy* was issued in July, 1999.

During its deliberations, the committee identified many factors that were common to large construction projects or "megaprojects" that were delivered successfully from the standpoint of cost, schedule, and scope. These characteristics were described in an appendix to the final report and are presented here for the benefit of all those with an interest in project management.

INTRODUCTION AND USE

Experience has shown that more planning and skill are necessary ~~eded~~ to develop, sustain, and successfully deliver what can be deemed a "megaproject" than for a conventional construction project. The information in this booklet can be used as a benchmark against generally accepted characteristics of successful projects. The characteristics described do not define a process. They are formatted as a checklist for comparing a specific project with the characteristics of other successful projects.

Checklists are reminders for good managers. The following checklist can be used for all important projects—when the project is being prepared for the development of baseline parameters, as a post-mortem for identifying lessons to be shared with other project managers, or at any other time to check the health of the project and identify likely sources of problems.

The many characteristics of successful megaprojects are complex and are not well documented. Information is usually assembled to document what went wrong with a project rather than to document the circumstances of success. The list of characteristics of successful megaprojects that follows is based on the collective experience of more than a dozen highly knowledgeable professionals with experience in large-scale projects. Of course, not every item listed must be present in order for a megaproject, or any project for that matter, to succeed. ~~This recitation of characteristics does not attempt to say that each and every item listed must be present in order for a megaproject, or any project for that matter, to succeed. Rather its meaning and use should be to compare the characteristics of a project at hand with these characteristics to see how well that project stacks up.~~ If there is a good correlation, particularly if the characteristics listed as "essential to success" in each category are there, then the project should have a good chance for success. If there is little correlation and only a few of the essential characteristics are present, the parties responsible for the project should consider what can be done to improve the chances of success.

Although a sound, reliable project management system is very important to project success, the project management system alone does not guarantee success. Successful projects must be run by trained, skilled, talented, and experienced managers who can not only plan and manage the work well, but who can also handle external factors effectively. The organizational structure must also be designed for project success.

The conditions, qualities, and characteristics that follow will require sizing, shaping, and fitting for the wide range of construction projects, which have very different scopes or purposes (e.g., environmental cleanup, retrofitting facilities, routine construction, one-of-a-kind science projects). But a standard is a good place to begin the process of fitting and adjusting and setting up the project in a way that increases its chances of success.

GENERAL CONDITIONS

The following general characteristics apply to the project setting, surroundings, and sponsor. These conditions are generally external to the project itself but are significant factors in its success or failure. These conditions are divided into three categories: conditions essential to success; conditions important to success; and conditions beneficial to success.

Conditions Essential to Success

1. Project sponsors know what they need and can afford, where they want to locate the project, and when it must be ready for use or otherwise completed. The project has a purpose, and the benefits are clearly defined and understood by all participants.
2. The project has a champion in the owner's organization whose position and influence enable him or her to affect behavior and performance in the owner's organization that would benefit the project.
3. The sponsor/owner/user is clearly focused on the successful completion of the project throughout the life of the project.
4. Open communications, mutual trust, and close coordination are maintained between owner/users and project management during planning, design, construction, start up, and turnover of the completed project to the owner.
5. Project managers (in owners' as well as contractors' organizations) are experienced professionals dedicated to the success of the project. Each demonstrates leadership, is a project team builder as well as a project builder, possesses the requisite technical, managerial, and communications skills, and is brought into the project early.
6. Regularly scheduled management review meetings with prepublished agendas are attended by all interested project participants to coordinate actions and focus on moving forward and to act on potential problems and issues as they arise.
7. Contracts are clear and unambiguous. The responsibilities of owners and contractors are clearly understood by all parties.
8. Contract incentives are clear and unambiguous, appropriate to the performance objectives, and adequately compensate the contractor for the use of resources, risks, and performance contribution to the owner's objectives.
9. Incentives, as applicable, may be provided so that each contracting party shares in the benefits of improvements in project performance.
10. Risks are borne by the parties most able to manage, control, or reduce them. Therefore, owners bear the risks related to site conditions, external factors, and overall scope of the work; contractors bear risks for their own efficiency and performance in fulfilling the terms of the contract; owners and contractors work together to minimize total project risks rather than shifting them from one to the other.
11. Accountability for project success or failure is understood to be the responsibility of named key individuals.

12. The half life of the political sponsors that decided to proceed with the project exceeds the half life of the project. Thus, there will be no change in the political will during the execution of the project.

Conditions Important to Success

1. Request for Proposals and bid documents clearly define the project and the owner's requirements and expectations.
2. Pre-bid meetings with prospective contractors and suppliers ensure that all parties understand the owner’s requirements, limitations, conditions, and expectations.
3. Contracts are awarded on the basis of value, not just cost. Value includes demonstrated capability, experience, leadership, initiative, accepted projected schedule, and other factors directly related to the successful performance of the work.
4. Each party engaged in the project knows who that party’s customer is, what that customer is buying in both quantity and quality, and when that customer expects delivery.
5. The project organization and mission are clearly defined and understood by everyone. The roles and responsibilities for each key person are published, and the chain of command is clearly defined.
6. The depth, stability, and time commitments by key personnel are appropriate for the project to ensure low turnover in management and key technical positions.
7. Key project personnel from all participating entities are trained in public affairs, public information, effective communications, and information management.
8. A partnering arrangement is used, in which owners, users, contractors, stakeholders, regulators, and public representatives are brought together at the outset to come to consensus on the tasks that must be accomplished and the roles and responsibilities of each.
9. The public and stakeholders understand and accept the purpose of the project, the types of technologies to be employed, the processes used to award contracts, and the past relationships of the contractors with the local labor force, suppliers, and vendors.
10. Acceptance, concurrence, and buy-in are obtained from all stakeholders are based on their being well informed and involved in the decision-making process leading up to the start of the project. Stakeholder acceptance is high throughout the project maintained by proper control of the work, good communications, diplomacy, and consideration.
11. The project has a single information technology standard and agreed upon protocols that have been published and are understood and observed by all.

12. Contract types and terms are appropriate to the risks and to the allocation of risks between the parties.
13. Adversarial relations are avoided through good contracts, good communications, and teamwork, from the earliest stages of the project.
14. If appropriate to the scope and duration of a project, an owner-controlled insurance program provides wrap-around coverage for all parties engaged in the work.
15. Individual contractors, to mitigate their own project risk and based on the risks inherent in their work, may carry insurance separate from the owner-controlled program insurance.
16. The participation of individuals and contractors representing protected classes is a priority for project management; programs are in place that encourage participation through training and administrative assistance in obtaining prequalification or other requirements for participation.
17. Good labor relations and training programs ensure an adequate supply of skilled workers and lessen the chances of unjustified work stoppages, jurisdictional disputes, and other personnel issues.
18. Owners and contractors can explore methods and practices to improve project efficiency and effectiveness.

Conditions Beneficial to Success

1. The project is relatively immune to external factors that could affect the scope, mission, quality, cost, or duration of the project.
2. The project is open to the outside for receiving information, advice, improvements, technology, and independent assessment.

SPECIAL CONDITIONS

The following characteristics relate to a particular project and apply to the owner, the contractor, the contract, budgets and funding authorizations, project operations, and similar project-specific characteristics.

Conditions Essential to Success

1. Scope, cost, schedule, and quality are closely interrelated, and a change in one will probably cause a change in one or more of the others.
2. The benefit-to-cost ratio for the project is high enough that increases in costs within the preset confidence limits will not threaten the viability of the project.
3. Budgets include allowances for explicit contingencies.

4. Budgeted funds are planned and committed without interruption so that progress will not be delayed or halted at the end of the fiscal year or other interruptions in cash flow.
5. An integrated project control system is in place that reflects the budgets, work breakdown structure, and schedule of values to a level that relates tasks, budgets, and schedule.
6. Leading indicators of problems are identified and closely monitored for early signs of trouble so that corrective actions can be taken.
7. Actual cost and schedule performance are compared periodically with planned performance through an earned value method system and performance indicators that report trends in both current and projected costs and schedules. Reports are provided to participants at regular intervals for their information, corrective actions, and response.
8. A rigorous, formal configuration management/change control process is in place to deal with all configuration issues or changes in scope, schedule, or costs beyond a stated threshold.
9. All proposed scope or design changes are justified with regard to configuration and project objectives and are priced out and documented to include their effect on quality, scope, cost, and schedule, as well as their ripple (nonlinear) effects on reworking, schedule, and costs.
10. Decisions to proceed with changes in scope or schedule come through the change control process and through the chain of command after due, but timely, consideration of their impact on project completion time, cost, and performance.
11. Issues involving the environment, safety, or health are handled directly and efficiently with the primary focus on avoiding harm and mitigating exposure.
12. Safety is a primary focus of every project participant, and job specific training and coordination are uniform and universal.
13. Permits, easements, rights of way, cooperative agreements and other evidence of unfettered access to the work site and its surroundings are in place and available.
14. Stakeholders, regulators, and other interested parties have been briefed on the scope, schedule, and cost estimates. Milestones significant to each interested party have been identified and explained.
15. Trade-offs between risk and technology opportunities are examined quickly, carefully, and definitively to determine the best available technology in a given context.
16. The owner, designers, and contractors understand the risks, uncertainties, and sources of risk in the project, and are prepared to take action to mitigate them.
17. Contractors are brought into the project early so they can participate in the design process, work planning, design and build specialized equipment,

become familiar with the site and conditions, and become an integral part of the project delivery team.

18. Pre-existing labor agreements are consistent with the planned work, workers, materials, equipment, and processes planned by the contractors.

Conditions Important to Success

1. Planned rates of work are not constrained by the vagaries of annual appropriations or payment authorizations, which could increase contingencies in subcontract costs, disrupt the orderly flow of work, and generally increase costs.
2. Wherever possible, budgets are multiyear, updated, and extended annually.
3. Cost estimates and contingencies to account for margins of error or uncertainty include input from local and federal regulators, when appropriate.
4. The uncertainties in costs and schedules are estimated and include a range of impacts for public or political opposition to the project, as well as the lack of cooperation from local, state, and other regulators, especially if the project is unique and controversial.
5. Contractor safety records and statistics are available to the project manager and the owner. Problems are addressed immediately and constructively by the parties involved.
6. The roles and responsibilities of each party charged with quality control are clear, understood, not overlapping, appropriate to the work, and accepted by all parties.
7. A records and documentation program is in place to ensure that a documented history of the life of the project will be available.
8. A specific project-wide, nonjudicial disputes resolution process is in place to resolve differences of opinion or interpretation of the contract or the work so the project team can continue to work as a team.
9. Systems are in place to track and report progress against the cost and schedule baselines at regular, planned intervals. All parties actively participate in a lessons learned program to improve productivity, safety, and overall performance.

Conditions Beneficial to Success

1. Design-to-budget methods are used to track changes in material quantities and other costs compared to the baseline estimate.
2. Actual and budgeted costs of work performed are tracked in the field.
3. Suppliers and vendors are involved during planning and design to ensure that supplies of required materials and the latest technology are available.
4. An active, quality improvement program addresses every level of staff and all processes, as well as work products.

5. The project and all of its participants and contractors are ISO 9000 qualified.
6. Political influence, extraneous political and social factors, and other factors not related to successful execution of the project in terms of time, cost, and quality are controlled to limit their influence on project performance.

TECHNICAL CONDITIONS: SCOPE

Essential to Success

1. The scope of work is clearly defined in terms relevant to the project team.
2. Wherever possible, scope performance is defined in terms of deliverables or numbers of units of planned work to be completed by a time certain.
3. The quality assurance/quality control program is tailored to meet project-specific requirements, and the scope reflects both requirements and expectations according to the contract.
4. The project plan is based on employing best available, state-of-the-art technology, but not experimental or unproven technology.
5. Site conditions are well known and have been thoroughly investigated. Accurate information is available on subsurface conditions (geology, groundwater, toxic or hazardous materials, and other factors), hydrology, and meteorology.

Conditions Important to Success

1. A published project quality control plan establishes the requirements for quality by all staff and parties at all levels.
2. When an environmental impact statement (EIS) and record of decision precede project initiation, each and every environmental action noted in the EIS is translated into specific mitigation plans attached to each work package to ensure compliance.

Condition Beneficial to Success

1. The project does not take so long to execute that the science or technology on which it is based is obsolete before the project is completed.

TECHNICAL CONDITIONS: COSTS

Conditions Essential to Success

1. Project baseline estimates include all identifiable cost elements and contingency sums to account for items not yet identifiable at the stage of design development that supported the estimates.
2. Cost estimates, at all stages, reflect the level of detail and explicit contingencies consistent with the stage of design development to limit the likelihood of significant cost increases through design development following authorization of the project.
3. Through the change control process, explicit contingency sums are converted to explicit item costs, as items are identified and accepted by change control; the contingency is reduced accordingly.
4. Allowances for cost growth and unknown cost factors are developed through risk analysis, contingency analysis, or scenario analysis and are included in the cost estimate.
5. Costs are distributed and tracked against the baseline cost estimates distributed to work elements through the work breakdown structure.

Conditions Important to Success

1. Biases in the cost estimates are addressed through independent reviews of the assumptions and their impacts on the cost estimates.
2. Cost estimates objectively account for risks, changes, hazards, user/owner culture and rules, and similar nonexplicit factors that are likely to influence costs.

Conditions Beneficial to Success

1. A cost estimate, which is a statement about a future event, should be probabilistic to reflect the risks inherent in the project.
2. Confidence factors, or the likelihood that a given cost will not be exceeded, are associated with cost estimates at all stages to give project sponsors a clear idea of the risks of cost variances and overruns.

TECHNICAL CONDITIONS: SCHEDULE

Conditions Essential to Success

1. Schedules and cost estimates are prepared together based on the work breakdown structure and production rates, crew size, physical constraints, and other time-impacting issues.
2. Schedules, like cost budgets, include contingencies, and the contingencies are known and continuously managed by the project manager.
3. The benefits of early completion of work are high, and schedules are aggressive and planned to complete the project as early as possible.
4. To minimize exposure to internal and external changes, the schedule is aggressive and is pursued vigorously.
5. Milestones, including owner actions, are clearly defined, listed, tracked for performance, and continuously monitored against performance.

Conditions Important to Success

1. Schedule contingencies decrease as the work progresses, and fewer unknowns remain to be resolved.
2. Risk analysis and probability techniques are applied to task durations.
3. Independent reviewers evaluate the assumptions used in making the schedules and determine how realistic the major milestones and completion date(s) are.

Conditions Beneficial to Success

1. Critical equipment and materials are available to support the schedule.
2. The reasons for completing the project by a given date are clear.