

Foundations, Frameworks & Lessons Learned in Program Management^{1, 2}

Bob Prieto

Chairman & CEO
Strategic Program Management LLC

The delivery of complex capital programs worldwide is increasingly challenged by the depth and breadth of management skills required for successful program execution. Capital programs today continue to grow in scale and complexity; face growing human and critical material resource constraints; require global resources or as a minimum compete for them; and are increasingly sensitive to successful execution in terms of schedule, quality and cost. Program management in the engineering & construction industry is focused on providing this execution certainty by putting into place the organizational, management and supporting frameworks which are prerequisites for successful delivery of large capital programs.

This paper reviews the ingredients of a successful program management approach and specifically differentiates it from good project management. While many of the tools and techniques of successful program management are similar to those applied in project management, the focus differs in some fundamental and important ways.

Definition of Program Management

Program Management is the process of providing execution certainty to meet the strategic business objectives of an owner.

Program management requires a broader, more strategic focus than project management and tighter integration across all elements of the execution process including organizational enablement; program definition; stakeholder outreach and engagement; establishment of programmatic and technical requirements; development of top level execution strategies, schedules and budgets; risk planning and approach to risk management; acquisition and contracting strategy; execution planning; implementation of an integrated management and support toolset; oversight, management and integration of defined projects; assessment of cost, schedule, quality and health, safety and environmental (HSE) metrics; allocation of contingencies and ongoing risk assessment; and ongoing alignment of top level strategies to successfully achieve strategic business objectives.

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How Program Management Differs from Project Management

Program management differs from project management in several fundamental ways as illustrated in the table below. In the simplest of terms, program management is the definition and integration of a number of projects to cause a broader, strategic business outcome to be achieved. Program management is not just the sum of all project management activities but also includes management of the risks, opportunities and activities that occur “in the white space” between projects. While an individual project will employ a specific project delivery approach (design-bid-build, design/build, DBOM etc), program management may combine different delivery approaches across multiple projects to best achieve the desired strategic business objectives.

Parameter	Program Management	Project Management
1. Organization	Semi-permanent in nature, resourced to address the full range of business requirements associated with achievement of a strategic business objective. Resource requirements may be programmatic in nature and applied to all or major sets of projects undertaken to deliver the program	Transient organization in nature, resourced to address a limited set of requirements that may be more temporal in nature and not recurring through all project phases. Output oriented vs. outcome oriented
2. Organizational Alignment	Analogous to building a new company with a sharply defined strategic business objective. When existing owner organizations are adopting program management for the first time, organizational change management processes are an early activity to assure that owner elements understand their changed role in a program delivery approach	Team alignment around project and contract requirements. In joint venture or prime-sub project structures this alignment may include “cultural” alignment as well as team building activities
3. Outcome Definition	Strategic Business Outcome (enterprise viewpoint)	Defined scope, schedule and budget (output viewpoint)
4. Risk Management	Management of all risks associated with achievement of the defined strategic business objectives	Management of assumed risks
5. Requirements	Establish programmatic and system technical requirements and allocate as	Manage project to meet the allocated programmatic and

	appropriate to individual projects	system technical requirements
6. Interface Management	Management of all programmatic interfaces between defined projects as well as other programmatic interfaces with stakeholder groups	Management of allocated interfaces, if any, and all interfaces within the assembled project team
7. Execution Planning	Program wide execution planning including top level schedule, budget, performance standards, supply chain configuration and contracting strategy	Project execution planning consistent with agreed to scope schedule, budget. and performance standards
8. Sequencing	Sequencing of programmatic activities including defined projects; re-sequencing of projects and other programmatic activities as required to achieve the desired strategic business outcome	Sequencing of project activities to achieve project execution requirements within any programmatic constraints imposed by contract
9. Timeframe	Through achievement of strategic business objectives (more permanent in nature)	Duration associated with completion of project activities
10. Stakeholder Engagement	Identification and integration of stakeholders' interests and proactive engagement to assure achievement of strategic business objectives	Interaction with stakeholder groups only as contractually provided for

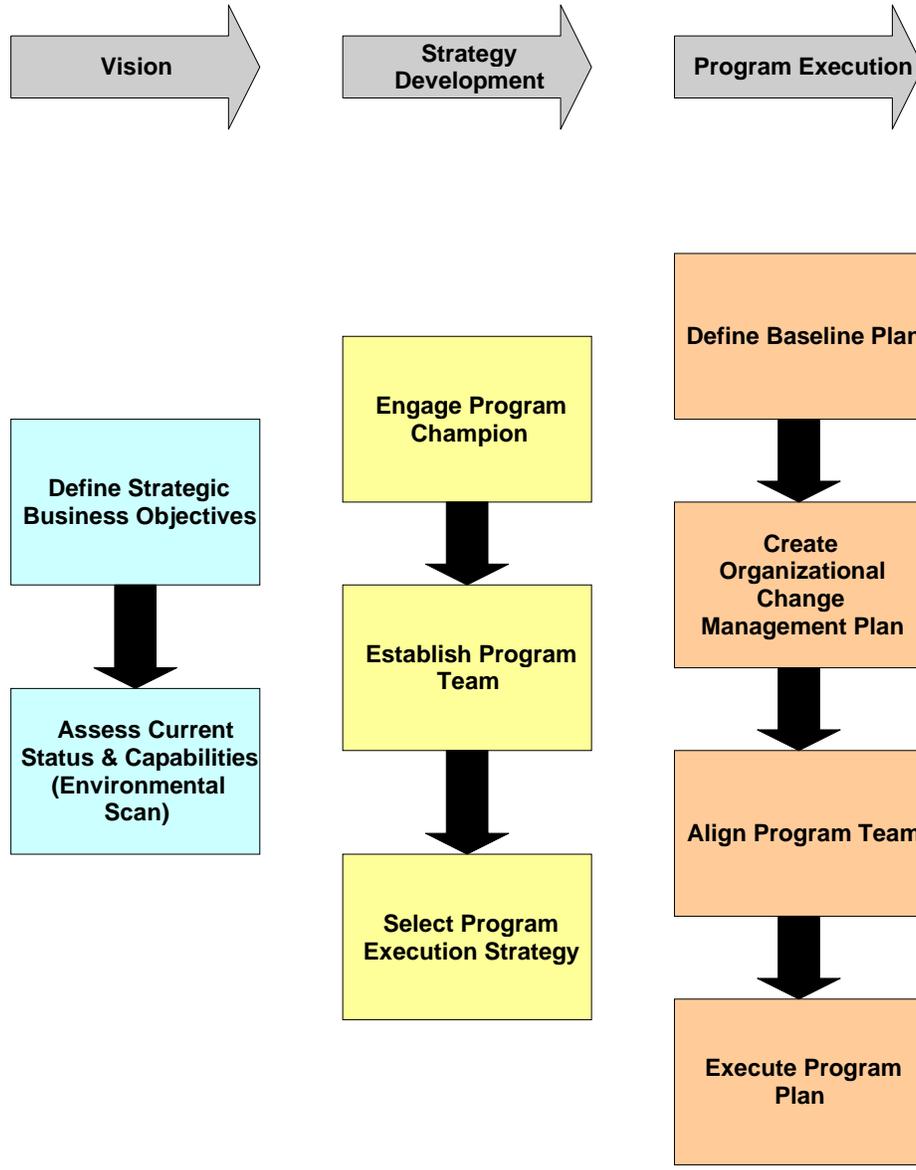
Organizational Change Management as a Foundation for Program Management

Organizational Change Management requires the consideration of two types of change that must both be managed synergistically in order to effect the strategic change that program management typically is utilized to accomplish.

Cultural Change -- those changes dealing with the people aspects of reorientation of organizations and teams to a programmatic focus

Tactical Change -- the basic changes in the way that individual projects are organized and executed

Key Steps in Organizational Change Management



Organizational Change Management (OCM) is the planned, programmed integration of a new business model into an organization including adapting the changes so that the transformation enhances relationships among participants and improves business processes. Proactive OCM focuses on innovation and skill development of people, proactively recognizing the effects of change, planning for them, and then helping the participants to develop skill sets and tools to support the change while dealing with the discomfort associated with it. Some of the change dimensions that the program team must address include:

- **Changed management roles** – The engagement by the Owner of a program manager will often require the owner's staff to assume a less directive and a much more policy setting and oversight role. This may create uncertainty about action in some Owner's staff that previously held directive authority and must now move to a guiding and assurance role. The effective communication of strategic objectives is critical.

- **Changed commercial patterns** – The types of management, engineering and project execution resources required for the program differ considerably from what has previously been required. Key program management resources exist in the engineering and construction industry but are scarce across all engineering & construction sectors. Commercial patterns will change to reflect this widespread competition for resources. Additionally, the reconfigured risk allocation and supply chain methodologies that a program management approach may require will also represent a paradigm shift in previously established commercial patterns.

- **Changed design process** – The program is typically much more strategic business objective and construction driven than what had been experienced by the Owner in prior efforts. Ease and facilitation of construction will require changed strategies for construction, procurement (program vs project) and design (standardized, simplified and changed constraints and opportunities).

- **Changed span of control** – All engineering, procurement and construction will not occur under the direct control of a singular project manager. As such, formal interface and configuration management will replace traditional project design meetings at the program level.

- **Increased importance of cross-cultural differences** – Design and construction work may be accomplished on a global basis, requiring multiple, diverse cultures to interact with each other in new relationships formats. The sense of time, distance, style and even the spelling and meaning of words will be different. These differences must be addressed head on.

An effective organizational change management program will:

- **Define future state and assess current constraints to achieving it** - Presenting the business reasons for a change is the first step towards achieving organization buy-in. If the people in the organization who are expected to go along with a change do not understand the reason for it, they are not very likely to want to participate - especially if a shift in thinking and behavior is required on their part. So, before asking or expecting people to change, communicate the rationale and the benefits.

- **Engage primary sponsor** – Every change effort has a purpose and goal. In reaching towards that goal, every person in the organization affected by the change should share the same vision, and be able to "see" what the new state will look like. And everyone should be able to communicate that vision to others. A vision statement is a picture in words that is inspiring and challenging, yet attainable. It should answer the unspoken questions: What will the future look like? What's in it for me? What's in it for the

organization? What's in it for our customers and stakeholders? How will we make this vision possible?

- Form and prepare project team – Management and work process challenges need to be clearly laid out. Emphasis needs to be placed on drawing out the team's concerns, hesitations and so forth so that these may be directly addressed. Barriers to change that are typically encountered include:

- People – This includes those who are threatened by the success of a new way of operating and how that success will affect their ability to return to doing things the old way after the program is done; those who tend to stay connected to their former chain of command and although they are in a new position, try to keep the old hierarchy in control; and those who view what is happening in their cultural (country or business) frame of reference or paradigm and react accordingly.

- Process - Process barriers include groups wedded to the processes they have created or have been using forever, and the walls that are created by established contractual and procurement processes. These processes have been honed over the years by lawyers and contracting types to reduce the risk to owners and to shift risk primarily to suppliers. Collaborating where one party holds all the risk is problematical at best.

- Technology - Everyone has his or her favorite mouse trap which they will champion as the best management technology to support the program management efforts. There are always legacy systems on the owner's side which must be accommodated by what ever the other team members bring. Much energy is expended in picking the right system and then getting everyone to use it. This must be an upfront decision since the implementation process is often extended.

- Communication - Another barrier often encountered is the lack of understanding that change is an evolutionary not revolutionary process. There must be a clear imperative for change and all should understand it is a journey not a destination. This must be revisited periodically throughout the OCM process to ensure continued progressive towards project goals and to avoid the development of pockets of "passive resistance".

The "new" way of doing integrated Program Management takes time, requires agility and flexibility, and needs total and ongoing support from the top.

Management Focus and Challenges in Program Management

Program management requires a continuing focus on overall strategic objectives, an ongoing assessment of the strategies put in place to achieve these objectives and active oversight and management of the tactical steps (projects and processes) taken to achieve these objectives. Program management involves prioritization and allocation of resources across multiple and in some ways competing projects. Decisions made, and not made, at the program management level can have far reaching impacts and as such governance structures associated with program execution are key.

In this regard, one of the greatest challenges is the management of the relationship between the entirety of the Owner organization and the program management group. At a minimum, a strong “partnering” relationship, sufficiently formal to assure comprehensive application, is required. This relationship is likely to have begun as part of the organizational change management process previously described in the case of the owner organization used to a multi-project vs. program approach. Alternatively, various program management structures incorporating “salt & pepper” elements have proven effective in facilitating this all important relationship.

Program management also requires a focus on overall program finances that transcends the considerations encountered on any one project. Finance, treasury and comptroller-type activities are integral to successful program management. These are complemented by the more comprehensive risk assessment, forecasting and management systems programs require.

Achievement of strategic objectives and comprehensive financial controls are built upon a strong planning framework. Plans must directly support strategic business objectives and be cascaded down into individual projects and processes. Metrics to monitor individual sub-plan performance are complemented by cross cutting metrics to look at the strategic performance of cross cutting and correlating factors. A clear sense of the “value of time” must permeate through all levels of planning with particular emphasis placed on the importance of effective initiation and ramp up of individual activities and projects.

Across all projects and processes the program manager must put in place a set of tightly integrated framework processes to enable, assess and proactively manage all program activities. These framework management processes, together with the technical capabilities and resources the program manager brings, are key features of successful application of a program management approach.

Program Management Focus & Key Challenges
<i>Sustained focus on strategic business objectives</i>
<i>Prioritization and allocation of resources</i>
<i>Governance structures</i>
<i>Interface with owner organization</i>
<i>Change management</i>
<i>Partnering implementation</i>
<i>Program finance</i>
<i>Continuous risk assessment</i>
<i>Planning framework</i>
<i>Strategic performance assessment</i>
<i>Value of time</i>
<i>Management framework processes</i>

Organizational Foundations, Supporting Frameworks and Lessons Learned for Successful Program Management

Successful program management requires a strong organizational foundation and the implementation of a comprehensive set of framework processes that transcend those required in a project context. A number of these framework processes are described in the next session but the list is not intended to be all encompassing. The range of issues to be assessed, managed and monitored is characteristic of differences between program and project management. Key to successful program management is the strength of the organizational foundation and degree of integration between each of these processes. While a range of individual tools exist to implement each framework process, benefits accrue when these tools are as seamlessly integrated as possible.

The lessons learned on several major programs have been captured and characterized in the context of these program management framework elements. In addition lessons learned with respect to organizational foundations are presented below.

The programs reflected in the lessons learned range from \$ 1 billion to over \$ 30 billion in size and from 4 to 30 years in duration and include both US and non-US program management delivery. Over \$ 125 billion of program cost is represented by these major programs. Program management lessons learned have been “sanitized” to protect the identity of specific programs. Input derives from program managers or other senior executives and in select instances from lessons learned documents prepared as part of the post mortem process.

Organizational Foundation

Organizational framework for the program management team is to be integrated with project(s) teams as well as with the sponsors teams. The project organization must be able to relate effectively to all levels both internal and external - including the government. Teamwork, cooperation, cross-attendance at meetings, and interactive reviews are paramount. Centralize control but decentralize authorities.

Clear definition of each organization's functions, responsibilities and interfaces is necessary at outset of program. Owner organization must take lead in development and issuance. Very experienced Owner and program manager staff is essential. Rapid decision making is key. Avoid excessive staff and middle management layers.

Owner's organization must facilitate decision making by key owner staff not just owner's senior representative. Authority and responsibility must be sufficiently delegated to the Program Manger and as appropriate to lower tier organizational elements. Value of time in large programs must be clearly understood and decisions processes developed and implemented in recognition of this.

Organizational Foundation (continued)

Ensure program implementation procedures including delegated authorities are supportive of the execution needs of a mega program. Authority must be delegated in each instance to the appropriate organizational level. Define roles and missions as part of a comprehensive implementation planning process. Teamwork is essential - a team of adversaries is not a team.

Owner's organization must be integrated with PM delivery partner because owner could not provide enough people with the correct skills to manage program correctly. Ratio of owner to contractor personnel on team was one owner for every five contractor. Total integrated PM team was 600 people. At outset, roles and responsibilities must be agreed upon to reduce confusion and improve effectiveness of the team.

Owner/PM organization with clearly defined responsibility and authority needs to be established at outset of project. Organizational foundation must enable rapid decision making.

Integrated team with owner as decision maker on scope, evaluator of performance and authorizer of payments. Program management plan detailed roles and responsibilities. Partnering used extensively to resolve conflicts. Ensure owner has articulated and program manager understands the owner's strategic business objectives including any constraints or phasing requirements. Program management roles and responsibilities, degree of integration with owner's staff, and associated processes and procedures must be clearly established at program commencement. Roles and responsibilities for all other organizational elements within the owner's organization and program team (designers, contractors, suppliers) must be similarly clearly defined. Integration is key to mega program success - schedule, cost, construction and many other items must be integrated across all organizational boundaries through implementation of a robust set of framework processes.

Program Management – Integrated Framework Processes and Lessons Learned

1. Audits

Program management assures that program and technical requirements are met not only by the Program Manager but also by the individual program activities and defined projects. Quality, safety and other technical audits are covered under other framework activities. Audits to assure programmatic compliance may include regulatory, contractual and financial or other fiduciary audits.

Program Management Lessons Learned - Audits

"It is necessary to conduct a detailed quarterly or semi-annual cost and financial analysis. The findings should be reported through the programs communication channels and project(s) status reports."

Audit processes must clearly define processes and procedures for dealing with audit findings.

Accuracy of contractors' records on time and material slips must be assured to ensure that there are not overpayments to contractors from misrepresentation of the classification of workers.

2. Budgeting, Fund Management and Allocation, Expenditure Approval and Tracking of Funds Committed and Expended

Program management requires objective oriented budgeting including identification of risk-based associated contingencies and allowances for acceleration or other defined changes contemplated by the defined strategic business objectives. Funding requirements for discrete budget periods must be well defined and where required excess cash management and investment programs must be put in place.

Forecasting of future funding requirements is an ongoing process and the impact of any changes in funding availability must be carefully assessed as part of the overall change impact assessment framework.

Robust fund approval processes and tracking of funds deployed and progress obtained closely monitored. Audit programs assure fiduciary responsibility in the application of the owner's funds.

**Program Management Lessons Learned - Budgeting, Fund Management and Allocation,
Expenditure Approval and Tracking of Funds Committed and Expended**

"Integrate ""earned value"" measurements with the control system. Implement training and discipline early so that the process is instilled in the program culture. Maintain effective 'checks and balances' through routine audits and exception reviews. "

Integration of cost, schedule, construction and all other framework processes is necessary to effectively plan and manage the program. Centralized control systems are necessary to avoid a multi-project approach with hidden risks and costs.

Expenditure approval processes must support decision making time frames.

Establish comprehensive project controls and management information systems at project initiation.

Centralized control functions (cost, schedule, QA) need to be established at the outset of the program and not layered on later, once problems have developed. Many entities tried to control funds flow and as a result extensive schedule delays occurred and price escalation was a problem. PM kept track of funding and onerous reporting requirements were a barrier to efficient program execution. Reporting was a major function of the integrated team because of the intense interest in the program. A web-based system was used that satisfied most clients desiring information. The system was installed late so maximum benefit was not realized.

Centralized program/project controls need to be comprehensively implemented and attention paid to multi-project cost and schedule factors.

3. Change Impact Assessment (CIA)

Program management requires an ongoing assessment of the impacts of external factors on the overall program's ability to achieve the defined strategic business objectives and to modify strategies or tactics as required to achieve success. An ongoing assessment of the impact of change, whether externally driven or the result of performance in one or more of the program activities or defined projects is required.

A CIA system analyzes the effects of change on project productivity ("disruption")

- effects can be identified well in advance of their occurrence
- sensitivity analyses can be performed by altering change conditions to test a wide variety of mitigation hypotheses

Comprehensive CIA provides the program manager with a wide range of benefits including:

- ability to implement cost avoidance strategies well in advance of incurring the cost.
- more comprehensive assessment of cost impacts
- early identification of total costs
- improved forecasting
- rapid sensitivity evaluations of schedule adjustments
- reduced change impact analysis costs through the use of standardized, automated tools
- higher degree of predictable project performance contemporaneous support for costs known to arise in the future (Fluor benefit)

Program Management Lessons Learned - Change Impact Assessment (CIA)

It has been consistently found that dealing with change issues quickly result in mitigating severity of impacts. Potential change tracking system is needed and all updated information provided on a real time basis. Regressing effects of multiple changes must be evaluated.

Change processes must be actively controlled and appropriate balance given to competing requirements. The impacts of any change must be clearly assessed in terms of schedule and cost including full consideration of disruption from changed sequencing. Impact of changes must be continuously assessed including the impacts from changed sequencing or changes to third party commitments. Change impacts must be communicated quickly and frankly to the Owner and not footnoted away.

Change process managed by PM in concert with owner. Too many levels of approval and too much bureaucracy reduced timeliness of progress.

Change process actively managed by PM. Owner knew that this was a zero sum exercise where additions to scope in one project had to be offset by reductions in other projects in the program .

4. Configuration Management

The objectives of configuration management are:

- 1) establish consistency among design requirements, physical configuration, and documentation (including analysis, drawings, and procedures) on a programmatic (across multiple projects), and
- 2) maintain this consistency throughout the life of the program, particularly as changes are being made.

Program Management Lessons Learned - Configuration Management

The basic elements of an effective program configuration management system requires starting the process at the very beginning of project development and keeping it consistently updated. A rigid and universal document control cataloging system is imperative. The configuration management systems is to be integrated with the master schedule and cost controls.

Program planning and interface management must be implemented early.

Project to project interfaces must be clearly understood including how these interfaces change over project execution. These interfaces must actively managed.

Identify and resolve interface issues during the design phase.

Design/Build approach utilized where the overall contractor for each project in the program was responsible for the design as well. Configuration was managed by the integrated team through design review and a change control process.

Design "ratcheting" must be tightly controlled through configuration management processes.

Use of full electronic design files by construction reduces RFIs. Standard specifications developed for the program along with standard construction details were excluded from value engineering exercises to maximize program wide standardization.

Design was managed by PM in concert with owner to assure that total program could be accomplished and balance was maintained in each project and total program. Continual decision making was required by owner to maintain control on total program and ensure delivery of desired scope on individual projects.

5. Constructability Analysis – Systemic

A major source of cost and schedule growth on large complex programs is associated with inadequate interface management. These interfaces may be between the program and external stakeholders; between design and construction contractors; or between discrete construction projects. An early and systemic constructability analysis facilitates the identification of opportunities to modify the program's supply chain and contracting strategy; identify logistical, labor and supply constraints; and analyze program wide sequencing of work on a "4D" basis.

Successful program management will ensure that:

- early construction involvement is considered in development of contracting strategy

- project schedules are construction-sensitive
- basic design approaches consider major construction methods
- site layouts promote efficient construction
- advanced information technologies are applied throughout project

Program Management Lessons Learned - Constructability Analysis – Systemic

Utilize formal review processes starting at the early preliminary engineering phase. Coordinate across boundaries both internal to the program and external. Along with technical assessments search for recommendations that mitigate delays, errors, omissions and claims.

Program wide constructability transcends typical project constructability reviews by considering project to project interferences, supporting infrastructure requirements and timing, interdependencies between projects and opportunities to leverage temporary facilities and select procurements on a multi-project basis.

Constructability planning and analysis must begin at the outset of the project; cannot wait until preliminary design or later.

Organizational design should promote seamless transition from the design to construction phase on discrete projects.

An integrated PM team is essential to manage constructability of 3400 discrete projects in the program. Some required phasing while others required management of precedence of construction.

"Early explicit design consideration of constructability aspects to minimize construction costs and time (less important with design-build delivery)"

Integrated team required to be aware of and manage interactions between various projects in program. Sensible sequencing and attention to potential interferences must be managed continually to improve productivity and maintain schedule.

6. Construction Mobilization

Complex program implementation may limit or modify an individual contractors approach to construction mobilization. Factors modifying typical mobilization may be lack of typical supporting infrastructure; site remoteness or environmental conditions; or restricted site access as a result of required programmatic sequencing.

Program management requires early identification and mitigation of such constraints through an ongoing enablement program to ensure that a project contractor may mobilize in the most efficient manner within the overall program requirements and constraints

Program Management Lessons Learned - Construction Mobilization

"Focus on development of program management plans, implementation processes, and building a solid IT infrastructure - priorities communication channels and procedures. "

Construction mobilization must ensure that programmatic mechanisms are in place to ensure that construction on any program element is not initiated until required construction and quality assurance systems are in place. Policies need to ensure that construction is not initiated on any program element until all construction specifications have been met, processes for identification and reporting deficiencies are in place, and programs for tracking repair or replacement of any deficient construction prepared.

Cost type contract enabled start of work before design was complete on many projects in the program. Contractors were mobilized early to allow set up as rapidly as possible.

Projects where construction contracts were let prior to completion of all environmental and ROW acquisition facilitated construction mobilization. Project planning report utilized successfully to transition each project from planning to execution stage. Historical context, programmatic standards, interfaces and key assumptions all captured in report.

Integrated mobilization required because work site was constrained by size.

7. Construction Technology

Program management affords the opportunity to leverage large scale construction technologies across multiple projects. Availability and applicability of various construction technologies to a major program will influence project execution and contracting strategies. Examples of some construction technologies that will influence overall program execution include:

- modular construction including extensive pre-fabrication and pre-assembly
- rigging engineering
- welding and non-destructive examination
- special environmental controls and shelters
- specialized subsurface mapping and ground stabilization
- RFID and extensive owner furnished material programs

Program Management Lessons Learned - Construction Technology

"Stay abreast of new technologies available by continuous survey of tools, materials, methods, processes used in the industry. Rely upon the data base and archive collections of industry leaders such as CII, ASCE, CMAA, AIA, etc."

Concrete and other material testing protocols at the construction site as well as in the materials lab must be implemented early, documentation completed and periodically assessed to ensure they are meeting the program's requirements.

Limited availability of advanced construction skills at outset of program required construction technology to be simple during initial phase. As program progressed and training could be conducted, technology was advanced to modern techniques.

Dependence on leading edge manufacturing technology and techniques drove changing owner's requirements which in turn required a dynamic approach to program management.

8. Contingency Management

Program management often employs shared contingency programs for critical projects with high uncertainty levels. Such programs incentivize project level performance while providing increased cost certainty and a program level.

Program Management Lessons Learned - Contingency Management

Use probabilistic modeling for development of contingencies in time and cost for each activity-based item.

Owner must clearly recognize the need to plan for uncertainties.

Contingencies must accurately reflect risks facing the program and be linked to the outcomes from a formal and comprehensive risk management process.

Construction Management oversight was performed by the integrated team. Oversight included quality assurance and safety review to ensure that the owners standards were being met.

Construction Management oversight on each project in the program was done by the integrated team to ensure that the requirements of the owner were met.

9. Cost Estimating

Program management involves determination of the probable system total installed cost (TIC). Probable system costs include consideration of all project uncertainties on a probabilistic basis using Monte Carlo risk assessment techniques.

In a large complex program this cost analysis must consider cost correlation across multiple elements of supply and multiple projects. Examples of such cost correlation include:

- overall local and regional labor and specialty craft supply and attendant cost
- fuel cost, impacting not only operating costs associated with direct construction but also material transport and manufacture costs
- steel availability and costs that may impact not only project structural steel but cost and supply times for major manufactured components, forgings and potentially logistical and supporting infrastructure of the project
- project bonding availability and costs associated with weak financial performance by sureties

Total installed cost includes cost elements typically not seen at a project level such as:

- working capital
- client furnished materials (CFM)
- project finance costs
- initial project startup and testing materials
- initial spares
- property acquisition costs
- environmental permitting and mitigation costs
- program manager and owner costs
- legal support costs
- excess insurance costs
- programmatic currency or commodity hedges

Program Management Lessons Learned - Cost Estimating

"Integrate risk analysis with cost estimating, a process that integrates contingencies into activity cost and time."

Cost estimates must accurately reflect current market conditions as well as prospective trends. Competition for key resources is increasingly global in nature. Additionally, the distorting effect of implementing a large program in a remote of resource constrained area.

Fast track nature of the program can drive program manager to build upon cost estimating done by the main general contractors. Estimates so developed must be negotiated with the contracts managers to ensure adequacy and correctness. Final agreed amount should be a not to exceed figure with a fixed scope. Changes can be made that affect price but approval of the integrated team must be required.

Conceptual cost estimating must be done by an integrated owner/ PM team to make sure that the entire program is delivered within the funds available. Relying on designer or constructor estimates for individual projects is not good enough to maintain the required program control.

10. Ethics Training and Compliance

The semi-permanent nature of program management necessitates the establishment of a robust ethical culture and management framework. Ethics training, whistleblower and inspector general type processes may be required depending on program circumstances. Potential conflicts of interest must also be proactively addressed.

Program Management Lessons Learned - Ethics Training and Compliance

Training exercises on ethic policies. Use lessons learned for ethic breach. Exploit ethic practices for visibility.

Program-wide implementation of common ethics and compliance training programs across all program participants provides measurable benefits. Inspector general (IG) functions that may be required by the Owner should be embraced and the IG kept apprised of project evolution on a current basis.

Ethics training needs to encompass all staff not just managers. Compliance systems need to understand the ability of line employees to take actions that are in consistent with program ethical requirements.

Ethics training was provided to the entire integrated team at the beginning of the program and refreshers were provided at various intervals to keep the subject in everyone's mind.

11. Insurance

Insurance management represents a major project cost and opportunity. The design of an insurance strategy and management program should flow directly from the programmatic risk analysis.

Decisions should be made as to which risks are retained as part of an owner-controlled insurance program (OCIP) and which risks are best transferred and managed as part of a contractor controlled insurance program (CCIP). As program scale increases there is the potential for one or more CCIP programs being used in conjunction with an OCIP for excess and retained risks.

Program Management Lessons Learned - Insurance

Seek opportunities for blanket coverage umbrella policies.

Owner Controlled Insurance Program (OCIP) was invoked about half way through the program which required significant coordination between the owner, the PM and the providers. Better to decide at outset of program.

12. Knowledge Management

Program management affords the program execution process with the opportunity to capture and transfer best practices and lessons learned across multiple projects. The objective of such processes is to improve project execution certainty, avoid known problems and improve productivity through deployment of best practices and continuous learning.

Program Management Lessons Learned - Knowledge Management

Ensure the credibility and reliability of knowledge sharing and how it will fit specifically to the program objectives.

Knowledge management in a programmatic setting must ensure that any deficiencies identified during the construction phase are thoroughly investigated, corrective action taken, systemic lessons learned identified and knowledge shared broadly within the program management team.

Knowledge management was enhanced through the use of a web-based program management system. This helps reduce the negative impact of turnover on the integrated team.

Process documentation was used to provide continuity and ensure that knowledge was passed from project manager to new project manager.

13. Legal

Program execution requires management and consideration of a range of legal issues not typically encountered on a project basis. These issues may include:

- monitoring of legislative or regulatory issues that may impact achievement of strategic business objectives
- interaction with various stakeholder groups including negotiation of agreements, defense of suits and management of legal processes including land acquisition and permitting
- support of program manager “governance” activities
- “notice” processes
- review of contractual basis of claims
- management of dispute resolution and arbitration processes development of contract forms and review of special provisions

Program Management Lessons Learned - Legal

Establish accountability policies parallel with development of program practices and procedures. Provide external oversight to ensure basic compliance with legal and regulatory objectives. Prompt governance and integrity standards through management leadership.

It is essential to focus on environmental, regulatory and permitting issues at project commencement and to adequately reflect cost and schedule uncertainties in overall program plan and execution strategy.

Right of way and other property acquisition needs must be recognized and planned for early in the implementation of the program. Regulatory agencies and processes must be clearly understood and clearly provided for in overall program schedule and sequencing.

"Broad range of all significant Stakeholders (beyond all aspects of the client) must be identified and targeted early in Program Management development. Building the broadest base of consensus reduces risk of negative budget/schedule implications but requires diligent proactive steps. Program Management should include early direct relationships and consensus building with:

- * users of planned facility*
- * nearby community/neighbors*
- * business and civic organizations*
- * disadvantaged business enterprises and other special interest groups*
- * environmental agencies responsible for approvals and permitting*
- * affected industry at large through respective organizations (contractors, designers, trucking etc.)*
- * other responsible public agency technical staff with some responsibility (federal/state/local government, regional planning, zoning, financing etc.)*
- * elected officials (local, state and federal) as appropriate and dependent upon involvement (don't rely on others for this coordination)"*

Concurrent reviews of environmental submissions by all owner elements to reduce program schedule. Stakeholder commitments include in a special conditions section of affected project contracts.

14. Life Cycle Cost Analysis

Many strategic business objectives to be achieved through a program management approach may be driven by life cycle cost considerations as opposed to just first cost considerations. Programmatic life cycle cost analysis may drive different programmatic and technical requirements that those simply associated with achieving a defined cost or schedule objective.

Program financing may be highly influenced by life cycle cost projections and as such this may be an ongoing activity influenced by changing cost relationships and the development of new

materials or technologies. Business strategy and market driven shifts may also cause strategic business objectives to evolve during program execution.

The contribution of project acceleration to reduced life cycle costs is one area of major focus.

Program Management Lessons Learned - Life Cycle Cost Analysis

Use quantitative decision methods and cost efficiency indexes such as cost/benefit ratios and NPV. Prepare an asset management plan.

15. Material Management

Program management affords the opportunity to leverage procurement of select materials and services across multiple projects. Concomitant with such a strategy is the need to track, receive, store and dispatch such materials across multiple projects at multiple points in time until such materials have been incorporated into the permanent construction. Comprehensive material management employing a fully integrated suite of tools to address each step in the material management process is essential. Material acceptance and testing activities may also be integral to such processes deployed on a program wide basis.

Program Management Lessons Learned - Material Management

Create an integrated system for sharing material specifications, change requests, orders, inventory, and forecasts in real time with all suppliers, carrier, and end users for control of supply chain inventories. Material management programs must ensure and project level deficiencies are evaluated for programmatic implications.

16. Modularization

Repetition of components, constrained or costly labor situations, harsh environmental conditions or the need to open up additional construction fronts or initiate construction in advance of site availability are all drivers to a program approach to modularization.

Program Management Lessons Learned - Modularization

Identify repeating elements and physical features that can be modularized resulting in savings of time, cost, and efficiencies. Build prototypes for early planning and approvals.

A programmatic approach to execution will allow certain systems and structure to be considered as if they were owner-furnished equipment to be installed on one or more projects in conjunction with other project activities. The choice of modularization as a key program strategy reconfigures the project execution supply chain, necessitates the use of compatible or common design platforms with 3D or 4D capabilities.

The mod yard becomes an added construction site with each module treated as a separate project. Programmatic activities include general mod yard management and oversight activities in addition to those associated with each of the discrete

projects being performed at this site.

17. Operations & Maintenance

Large scale programs may result in one or more projects being put into beneficial use prior to completion of the overall program. Operations and maintenance of these initial phases needs to be carefully considered within the context of overall program goals and ongoing construction activities. Appropriate post commissioning performance for these early facilities should also be assessed to facilitate improvement in the balance of the capital delivery program.

Traditional owner planning activities related to initial spares and consumables need to be considered as part of a programmatic approach. Operational facilities add a degree of complexity in overall program planning and site security and safety.

Certain operational facilities which may offer added programmatic opportunities during the construction phase include:

- power supply and distribution
- potable water supply
- waste water and sanitary waste management
- permanent fueling facilities
- permanent port, rail or other logistical facilities
- central warehousing
- administrative facilities
- site wide cellular services

Program Management Lessons Learned - Operations & Maintenance

Start early in the program development with the gathering, cataloging and indexing of operations plans, manuals, and spare parts listings. Incorporate operations and maintenance people in the design reviews.

Continuously evolving operations, maintenance and other stakeholder requirements have a significant impact on efficient project execution and communication of impacts must be openly and actively dealt with.

The program parameters required turning the projects over to a third party when completed so the commissioning was aimed at people who had not been involved from the beginning of construction. This proved very challenging.

Operating and maintenance requirements must be defined in sufficient detail at an early date to avoid cost and schedule impacts associated with decisions/changes at later program stages. "Early explicit design consideration of maintaining operations during construction (if applicable)"

Engage operations and maintenance staff early in the design process to avoid late stage design changes.

Proper commissioning is required to make sure knowledge about operation and maintenance of newly installed systems was transferred from installer to owner.

- operational staff housing (as supplement to construction camp requirements)

18. Procurement

Program management provides the opportunity to achieve increased leverage on total spend through consolidation of select procurement activities related to major commodities, common equipment and major services. A program management approach will likely result in increased usage of common supply contracts and CFM to discrete projects. A programmatic procurement strategy increases visibility of common cost drivers and opens up additional management strategies and hedging options.

Programmatic procurement activities will also include more comprehensive and robust activities related to:

- supplier diversity
- supplier quality surveillance, including permanent in-shop teams for major suppliers delivering throughout the full program cycle
- material management
- material transport and logistics, including forward contracts
- supplier integration, including increased pre-assembly
- export/import control and expedited customs processes
- escalation and hedging strategies
- performance benchmarking
- warranty provisions and durations
- required spares and commissioning support
- implementation of supplier relationship agreements

New contracting strategies are also facilitated through a program approach to achieve strategic business objectives including use of a:

- master electrical contractor
- master automation contractor
- dedicated startup & commissioning team
- procurement of select facilities on a delivered service basis as opposed to a direct ownership basis (off-balance sheet financed; paid for usage or availability of service; eg. power, potable water)

Program Management Lessons Learned - Procurement

Today and more so in the future major programs rely upon electronic data communication technologies to market, purchase, and manage resources. Programs are to reengineer to exploit e-business processes; build the supporting electronic systems (internet and private networks) and employ electronic systems for economic benefits. Develop strategic vendor selection processes.

Contract packaging must reflect a programmatic approach. This will likely drive changed contract form and a reconfigured supply chain.

Contracts were written by others and handed over to the integrated team to manage but any changes had to go through a rigorous change process. Because the contracting staff was constantly turning over, delays and extra work occurred. Attempts to reduce turnover in the contracting staff eased the problem somewhat.

Contract form modified to address full range of optional services to expedite decision making and project execution.

Contracts were written by the owner but managed by the PM. The PM learned the owners procurement procedures and managed by them.

19. Productivity

Productivity improvement programs lend themselves to implementation on large scale capital construction programs. Examples of elements of such programmatic processes include:

- capture and sharing of lessons learned across all projects and program work processes
- common labor incentives for safety performance or value creating ideas
- labor retention and craft training strategies
- creation of a common program “culture”
- implementation of formal partnering programs with individual project teams
- entrepreneurial processes to keep the program management team focused on strategic business objectives and to avoid beaurocratic inertia from setting in.

Program Management Lessons Learned - Productivity

"Have established milestones and metrics for intermediate measurement of progress, performance, and productivity. Ensure a positive work environment that encourages high performance and expected productivity."

Impact of program disruption due to evolving requirements must be considered in establishing program productivity requirements.

Productivity was seriously denigrated because of the complicated bureaucracy that was put in place. Approval authorities were too numerous and everyone could say no but few could say yes.

Identify any design phase "proof of concept" test early on in design process to facilitate timely receipt of test outputs.

20. Project Security

Programmatic implementation of project security increases the range of tools available to ensure protection of personnel, materials and facilities under construction. Depending on the program requirements this may include site physical security; construction camp policing; vehicle and equipment tracking and recovery programs; personnel vetting and monitoring activities; rapid response capabilities at various levels; monitoring of potential criminal activities, intelligence gathering and interaction and liaison with local law enforcement. Data and other electronic security is increasingly an aspect of large complex programs today. Program security needs go well beyond those experienced on discrete projects.

Program Management Lessons Learned - Project Security

"Establish a plan for identifying and prioritizing all common threats and vulnerabilities. Program IT infrastructure has become an area of significant concern. Security risk events are to be integrated with the risk management process."

Project Security was the responsibility of the various contractors doing the individual projects. The integrated PM team had to put in place a group to coordinate security between various contractors to improve efficiency and effectiveness.

21. Risk Management

Programmatic risk management must implement an ongoing, structured approach focused on the identification, assessment, management, mitigation and provision for a wide class of risks that transcends the sum of the risks associated with individual projects. Attention must be paid to management of uncertainty and consider not only traditional qualitative and quantitative uncertainties but also the risks associated with a wide spectrum of events. Probabilistic techniques are typically employed and the initial risk assessment serves as a baseline against which project execution success is assessed and contingency modeling and release is managed.

Risks considered in a program approach that are not typically considered in a project context include:

- revenue risks associated with timely facility startup
- financing risks
- interest rate risk
- inflation/deflation risks
- credit risks
- f/x risk on procurement and hedging activities
- interface risks
- stakeholder or other third party risks
- changed labor framework driven by program
- timeliness of approvals and permits
- government action or failure to act
- customs costs
- common cost factors (energy, steel, transport etc)
- additional taxes and fees
- expropriation
- defaults
- changes in labor laws or visa requirements
- force majeure
- emerging environmental/societal issues (examples – greenhouse gas emissions/ carbon neutral project; water recycle and reuse; local economic development)
- craft skill levels available to project
- uninsured risks
- corruption
- cultural and cross cultural issues
- corporate social responsibility and stakeholder risks
- scale related risks
- intellectual property related risks
- lost opportunity risks
- time to market risks
- total bonding capacity available to project
- energy availability and cost
- total bonding capacity available to project

Program Management Lessons Learned**Risk Management**

"Risk management methods are not to be static and are to be integrated and linked to program budget estimates and the master schedules. Mitigation strategies are to include contingency modeling for cost and time impacts; use deterministic and probabilistic methods."

Critical program element is the decision process.

Risk management from a programmatic basis needs to accurately consider risks created through changed sequencing and timelines for individual projects created by varied stakeholder groups.

Risk management processes must ensure that propagation of deficient practices, processes and oversight mechanisms is not enabled through a programmatic approach.

Comprehensive general Outreach program is also a risk mitigator.

Establish an approved Communications Plan initially. Elements include:

- * program website kept up to date and easy for lay audience to understand*
- * use simple graphics/visualizations to illustrate more complex aspects*
- * secure section of website to facilitate internal management information and decision-making*
- * periodic program newsletters to broad audience of interested and affected parties*
- * establish personal media relationships for the program and develop a proactive media relationship plan (get in front of any bad news and stress good news in advance)*
- * establish a Crisis Communications Plan with appropriate parties for the unexpected, particularly during construction*
- * some programs will require Security Plan provisions for high risk facilities (design, construction and operations)*

Comprehensively identify program uncertainties, provide for them and identify and implement mitigating strategies before adverse events materialize and impact overall program progress.

22. Safety

Programmatic consideration of safety should include the interaction at a human and physical level between all projects not just within the battery limits of a given project. Safety and associated environmental and health standards must be consistently applied across all projects.

Programs with phased operation of facilities must consider operational risks to the surrounding construction workforce. Safety processes must recognize that the external factors influencing the safety of a given project will evolve over time and may not be intuitive to project related safety operations.

Program Management Lessons Learned - Safety

Create an environment of safety awareness by getting everyone involved, generating safety talk, and maintaining a safety incentive and reward system. The safety program is to have solid foundation starting with the top program executives from all contractors, consultants, and owners.

Owner commitment to safety is essential to the Program Manager successfully implementing a program-wide safety program. Not just lip service.

Any system, structure or component that could jeopardize the health and safety of the public must be able to comprehensively demonstrate that all management, quality and safety processes have been rigorously applied.

Institute comprehensive safety program for both users and constructors during the construction phase

Clarify design responsibility for any temporary works, in particular for any temporary works benefiting multiple projects in the program.

Engage safety staff early in program development. Conduct safety reviews of preliminary designs in parallel with constructability reviews.

Safety was managed on an integrated basis where owner safety procedures were managed by the PM integrated team. Contractors were required to enforce owner safety procedures during construction.

23. Standardization

Significant benefits may accrue to the program through implementation of a high degree of standardization across the various projects and processes encompassed by the program. Increased use of CFM and modularization and pre-fabrication facilitate standardization. Opportunities for added supply chain leverage will be created, tool requirements simplified, waste reduced, lessons learned, best practices implementation accelerated, and project execution flexibility accelerated. The ability to reuse elements of design including construction details aids the overall acceleration of the schedule.

Program Management Lessons Learned - Standardization

Program standards are important to define the program and all its process elements for control and management. At the same time, the standard should allow flexibility to each project or functional unit to make acceptable changes to fit its particular needs. Standards should be continuously evaluated and improved as experience is gained.

Design standards were established at the outset which helped control configuration and minimize changes caused by non-compliant design

Design standards and criteria must be developed early and applied consistently throughout the entire program.

Consider economies of scale for standards, methods and materials across multiple projects.

24. Technology

Common technologies for sharing 3D design information between designer, suppliers, fabricators and project construction teams act to reduce interferences and RFIs. Other technologies that lend themselves to program implementation include:

- construction simulation technologies
- site personnel and mobile asset monitoring
- wireless networks for construction
- RFID for site materials management
- materials logistics management
- fleet maintenance and management
- construction equipment automation and monitoring
- automated tool and supply management
- site position recognition technologies
- site survey and position systems
- sensing technologies for facility performance
- technology training tools

Program Management Lessons Learned - Technology

Most program organizations today use computerized data bases for the classification, documentation, storage, and retrieval of information about program phases or projects. However, it is very important to exploit construction management technologies that are compatible with MS Windows application, and allows collaboration access, and keyword finds. A data base storage should include archiving construction technology lessons learned and practices.

25. Training

Program wide training is an enabler for craft recruitment and retention as well as an enabler of long-term productivity improvement. A programmatic approach to training aids the development of a common program culture focused on safety and other key objectives identified as part of the suite of program execution strategies.

A structured training program facilitates the transfer of lessons learned and best practices in a common program labor pool across individual project boundaries.

Program Management Lessons Learned - Training

Training is to focus on program management competency collaboration, including the applications and techniques uniformly applied across the program, such as cost and scheduling systems, financial and budgeting reporting, and change management processes. Special training is to be organized for special project/program applications like constructability practices and value engineering reviews.

Employee training programs must include ethics, quality and safety training and provide for periodic refresher training.

Training on the integrated program management team was required because many members had never worked on a major program before.

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About the Author



Bob Prieto

Chairman & CEO
Strategic Program Management LLC
Jupiter, Florida, USA



Bob Prieto is a senior executive effective in shaping and executing business strategy and a recognized leader within the infrastructure, engineering and construction industries. Currently Bob heads his own management consulting practice, Strategic Program Management LLC. He previously served as a senior vice president of Fluor, one of the largest engineering and construction companies in the world. He focuses on the development and delivery of large, complex projects worldwide and consults with owners across all market sectors in the development of programmatic delivery strategies. He is author of nine books including “Strategic Program Management”, “The Giga Factor: Program Management in the Engineering and Construction Industry”, “Application of Life Cycle Analysis in the Capital Assets Industry”, “Capital Efficiency: Pull All the Levers” and, most recently, “Theory of Management of Large Complex Projects” published by the Construction Management Association of America (CMAA) as well as over 700 other papers and presentations.

Bob is an Independent Member of the Shareholder Committee of Mott MacDonald. He is a member of the ASCE Industry Leaders Council, National Academy of Construction, a Fellow of the Construction Management Association of America and member of several university departmental and campus advisory boards. Bob served until 2006 as a U.S. presidential appointee to the Asia Pacific Economic Cooperation (APEC) Business Advisory Council (ABAC), working with U.S. and Asia-Pacific business leaders to shape the framework for trade and economic growth. He had previously served as both as Chairman of the Engineering and Construction Governors of the World Economic Forum and co-chair of the infrastructure task force formed after September 11th by the New York City Chamber of Commerce. Previously, he served as Chairman at Parsons Brinckerhoff (PB) and a non-executive director of Cardno (ASX)

Bob can be contacted at rpstrategic@comcast.net.