Quality in Construction Management

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Achieving quality in the built environment is typically one of the stated objectives of all design and construction professionals, and it is generally assumed by the professionals that quality should be to the highest standard consistent with a clients budget constraints. Design and construction professionals look at a project's physical quality as the stated objective and cost and budget are dependant variables impacting the level of quality achieved.

Owners and investors, however, generally strive for a level of quality that is subordinate to, but in concert with, other objectives of value and financial performance. From an investor's perspective, financial performance is the stated objective, and quality and cost are the dependant variables impacting the objective. The point being, quality is a definable and measurable variable, but it is only one of the many objectives to be achieved. A project's differing stakeholders will have differing perspectives on the hierarchy of the numerous goals and objectives to be achieved and quality must therefore be defined and ranked. The number of failed projects where this simple principal was ignored is legion.

Achieving a defined level of quality in the built environment is separate but contingent upon achieving quality in the Management delivery system – if the Management delivery system is flawed, the quality results will be serendipitous and random, and a successful project will be the result of luck rather than a cognitive and predictable process. It is to this point that I will address the balance of this chapter.

First, the definition of quality should be expanded to include a project's intangible schedule and cost performance as well as its physical quality objectives. While there is a tendency to think of a project in terms of its physical manifestation, it's delivery on time and within budget are equally important objectives and deserving of Management delivery system attention. Second, it must be recognized that a project's construction phase is simply the final act in a long implementation process. As such, successful quality in the Construction Management process is rooted in the quality and decision making process undertaken during the project's initial programming, planning and design phases. While these issues are addressed in other chapters of this book, it is important to understand that successful quality management during construction can at best achieve the quality, schedule and budget objectives established at the project's inception, but stands little chance of turning a project around if quality issues were not addressed during prior phases. Critical to successful quality management during construction is the performance of the following design management activities and quality management tools:

- Preparation of a Baseline Report: this Report defines the goals and objectives (including quality level), program of spaces, conceptual designs, detailed budget, milestone schedule, and implementation plan including procurement packages and contracting approach. As the project proceeds through the planning and design process, it may be amended to reflect current decisions as to changes in scope or objectives. Its primary purpose is to serve both as a benchmark for decision making during the entire development process and as a basis for measuring project performance, including quality management performance during construction.
- Periodic Plan Checks and Quality Audits: during the design phase the design should be "frozen" at the 30%, 60% and 90% complete stage and both cost and quality reviewed against the Baseline Report. The concept of design to budget (the budget being based on the CSI 16 Divisions or other codes of account) should form the basis for estimating constructed cost, as the design becomes ever more definitive, and comparing the estimated cost against the budget broken down into the same code of account. Value engineering may also be performed at these times to optimize project

value and quality with the budget – frequently, quality may be maintained while decreasing cost; or, cost may be held constant while increasing quality. Both events add value to the project and are a function of quality management.

- Constructability Analysis: throughout the design process the project's constructability should be reviewed to ensure that logical, efficient and locally acceptable construction practices are incorporated in the design. This analysis should focus on three aspects.

  First: the systems and details are in fact practical and constructible – there is sufficient clearance and access to make the detailed field welds, bolt-up connections, equipment installations, etc.

  Second: the drawings are being developed into packages according to the construction plan such that adequate "for construction" drawings and "for information" drawings are produced to define the total scope of work for each construction package, or procurement package, and, in the case of multiple prime construction contracts, to define points of interface and coordination with all other packages.

  Third: that there is a logical sequence to the building construction such that major equipment can be installed in the basement, roof or intervening floors with out elaborate and costly "work-arounds". Issues to be addressed include vertical transportation requirements, crainage and other equipment requirements, field office, shop and storage requirements, laydown requirements, and prefabrication or sub-assembly to minimize onsite labor and/or labor and material lifts to high elevation.

We have defined "quality management" as the delivering an agreed and defined level of quality product on time and within budget. In accomplishing this feat, the perception of quality can vary significantly between the first world and the third world and the means and quality management tools used to deliver the required level of quality product may also vary significantly. In addition, the issue of project complexity and size will impact the quality management tools and techniques used to deliver the quality product. The point being that there is no "one size fits all" when assessing the issue of quality management systems in delivering product. In fact the argument can be made that the quality management tools used in delivering a specific project should be tailored and appropriate to the project's size and complexity, within the context of differing client expectations.

In western practice, the trend is to ever increasing sophistication and complexity based on computer based software tools, web based collaborative information sharing and data development systems, quantitative techniques, such as Six Sigma, which are increasingly used to measure and improve quality management systems and increase client satisfaction. Increasingly, the underdeveloped third world will demand to share in an increasingly globalized world economy, and the initial quality management tools to be used in delivering this largesse will be low-tech applications of traditional quality management techniques.

While the tools used in delivering this quality product will differ between first and third world projects, and in response to the size and complexity of projects, the principals driving quality management techniques remain constant.

While the importance of a quality management system throughout the project delivery process has been made and the point that "one-size-does-not-fit-all", the balance of this chapter will focus on the core quality management tools as they pertain to the Construction Management process.

Quality in Construction Management

For simplicity purposes, the Quality Construction Management system, or process, has been organized into four component elements: Cost Control, Schedule Control, Quality Control and Document Control.

Cost Control: As previously noted, delivering a project within budget is typically high on an owner/investors list of objectives, and the Cost Control process consequently of prime importance in meeting owner expectations. Also, as noted earlier, cost control must be established at project initiation and is best included in a project Baseline Report. Ideally, the project has been designed to budget, tendered and awarded at or below the approved budget. At this point, the Budget, broken down into a code of accounts according to CSI Divisions or another system of accounts, and the awarded Contract Price, similarly broken down, are incorporated into a master cost control document generally referred to as a Cost and Commitment Report. The Cost and Commitment Report (hereafter referred to as Report) may be a simple "Excel" spreadsheet or one element within a cost control software program such as Expedition – the point is that the Report include the following essential cost information: Original Budget; Original Contract Price; Approved Change Orders; Amended Contract Price; Outstanding Change Orders; Disputed Change Orders (potential Claims), and Forecast Completion Cost. Reference following example.

Project: XYZ **Cost and Commitment Report** **Date: January, 2000**

Item	Original Budget	Original Contract	Approved COs	Amended Contract	Outstandg COs	Disputed COs	Forecast Cost
Foundat'n	8,000	7,560	525	8,085	0	0	8,085
Strl Frame	17,500	13900	1,200	15,100	650	0	15,750
Curt'n Wall	23,750	21550	750	22,300	1,200	800	24,300
Int. Wall	9,700	9,850	600	10,450	700	600	11,750
Door/Wndo	6,350	6,400	0	6,400	400	0	6,800
Int Finish	8,500	8,000	0	8,000	0	0	8,000
Elevators	11,200	11,500	350	11,850	0	0	11,850
Mechanical	18,150	17,100	800	17,900	350	0	18,250
Plumbing	9,850	8,900	400	9,300	300	650	10,250
Electrical	13,600	13,750	675	14,425	420	0	14,845
Sub Total	**126,600**	**118,510**	**5,300**	**123,810**	**4,020**	**2,050**	**129,880**
Conting'cy	18,990						
Total	**145,590**						

In addition, a "Payments To Date" column is frequently included in the Report to track actual payments against the "commitment" – Original Contract Price plus Approved Change Orders.

An essential element in the Cost Control system is a Change Control process. It should be recognized that "changes" are part of the construction delivery process and the current emphasis on "zero defects", i.e. no changes, is the goal of Total Quality Management, as envisaged by Charles Deming and others, and as implemented through such programs as Six Sigma. In actual practice, "zero defects" is more applicable to manufacturing or highly repetitive processes where the large number of repetitive events and number of defects can be measured, put to statistical analysis and theoretically approach six sigma which defines zero defects.

Quality in Construction Management

In design and construction, zero defects, while theoretically possible, is in reality not achievable or possibly even desirable. This is due to the uniqueness of each construction project compared to repetitive manufacturing processes. Each construction project is comprised of a unique site, scope, materials, participants, contracts, and construction plan, such that it will never be repeated exactly the same way. Thus the goal of achieving zero defects for each and every unique project is unachievable.

However the goal of reducing defects to some minimal level consistent with the cost attendant to reducing defects to this theoretical level is very much the goal of quality construction management and the cost control / change control process. In effect there is a Law of Diminishing Return which states that at some point the cost of further reducing defects will exceed the value derived from such a reduction.

In effect, plan checks during the design phase of work have a goal of zero defects. A lofty goal but one that is not worth pursuing as these checks also have a significant cost and at some point the cost of continuing a plan check will exceed the "premium cost" of correcting the error(s) during construction.

From a quality management point of view, it is preferable to document field Change Order costs and correlate them against the cost of plan checks to determine historical trends and the value added of additional plan checks versus reduction in premium construction costs due to Change Orders. It is worth noting that there are three types of Change Orders, one of which is of significant concern from a quality management standpoint. First there are Owner requested changes, which, as is implied, are generally discretionary, and Owner initiated and approved.

Secondly, there are "omissions" which are scopes of work that were omitted from the contract documents but discovered in time such that they could be incorporated into the Work through the Change Order process without a premium cost. Finally, there are "errors" where contract documents have conflicting requirements that can only be corrected through some additional work and premium cost. In evaluating Change Orders and correlating their cost with the cost of additional plan checks; it is this premium cost that should be used in determining the degree of correlation.

A final note on the management of the Change Order control process – to maximize the effectiveness of the cost control process itself, Change Orders should be uniquely identified and processed expeditiously (within one month if possible). Independent estimates of cost should be prepared and Contractor negotiations concluded, if possible.

In the event agreement is not reached, the Change Order should be included in a Disputed Change Order category and held for final negotiations at the end of the project, with the understanding that it may end up as a contractor claim. The point is that the expeditious resolution of Changes, whether approved or disputed, facilitates control and allows costs to be trended to a forecast completion cost. Again, many projects slide into trouble through inattention or refusal to acknowledge legitimate changes, and it comes as a shock at the end of the project when the "piper is paid".

Schedule Control: The purpose of a Project Schedule is to create a workplan (in terms of activities, duration and logic), which defines and organizes project and construction activity and provides a basis to measure performance. On large complex first world projects Prima Vera P-3 scheduling software (or similar programs such as Artimis) is used to handle this complexity, while its simpler form Suretrack can be used on appropriate smaller projects, or sub-projects while retaining compatibility with P-3 as a master schedule. On complex projects it is advisable to break the master schedule down into ever increasing levels of complexity and detail, based on user needs. At the highest level, the schedule is generally a simple Milestone Summary Schedule showing start, completion and key interim events for major project elements and contracts.

Typically, this level of schedule is used for reports where a quick summary of major activity and progress is desired and to establish milestone completion dates to be incorporated into construction contracts. The next level is usually a Detail Summary Schedule showing, in increasing detail, the work breakdown structure for the total project. Specifically, foundation, steel erection, and major construction elements/activities are shown with start and completion dated and logic constraints to other work.

The next level is the Master Schedule which breaks the breaks the major construction elements/activities down into craft and trade level activity, showing start and completion dated and constraints and interfaces with other craft and trade activity. On large complex projects, scheduling specialists under the direction of a project manager and scheduling supervisor typically perform this level of scheduling with inputs from other responsible functional mangers, area mangers and contractor personnel. These schedules are generally updated monthly.

On large complex projects there is a final level of scheduling that is of critical importance in quality management of schedule performance – it is generally referred to a Four (or five) Week Rolling Schedule where the past weeks activity and actual performance is indicated and the next three (or four) weeks planned activities are scheduled. This schedule is usually prepared by area superintendents responsible for construction activity on a specific portion (area) of the project and for a particular discipline.

The area superintendent shows in great detail all construction activity in his area, including interfaces and constraints with other area superintendents in his area. The area superintendent will generally use a simplified but compatible scheduling software program such as Suretrack that can be “rolled-up” into the next level Master Schedule for updating and progress reporting purposes.

It was noted at the beginning of this section that the purpose of scheduling was to develop a workplan to manage the coordinated implementation of the project. Thus, the schedule is at the very heart of quality management in that it not only defines what activities and durations will be performed but how the project will be implemented. It will include and define the acquisition of land, permitting and approval processes, design and contracting strategy and durations, procurement and long-lead material acquisition requirements, agency interfaces and inspection requirements, and finally, commissioning and turnover activity. A project schedule is truly a map defining the projects development strategy and implementation process and, in keeping with our definition of quality management, schedule management is essential to delivering quality product and meeting client expectations.

The initial project Milestone Summary Schedule and possibly Detail Summary Schedule should be developed and included in the project’s Baseline Report, as the basis for timeline control during project implementation. During the design and construction phases of work, the various design consultants and contractors should develop and submit for approval the more detailed Master Schedule specific to their contract defining how they will proceed with their work and meet the Milestone commitment dates included in their respective contracts. The underlying premise is that the entity that is to perform the work is best suited to producing this level of schedule for two reasons. First – it is presumably the most knowledgeable about the resources available and how to best use them and second, it is forced to think through the logic of how the work will be accomplished and conveys “ownership” on it for the logic and process.