Construction Document Quality Crisis

David Stutzman, AIA, CSI, CCS, SCIP **Louis Medcalf, FCSI, CCS, SCIP**

ABSTRACT HEADING

Building design is becoming more complex because of increasing regulatory requirements, technological developments, and a panoply of new products. At the same time, design firms are being pressured by clients, market pressures, and contractors to produce documents is less time than previously. The challenge of achieving and maintaining a high standard of quality in design and the contract documents for those designs affects aspirations, satisfaction, profitability, and even the very existence of design firms.

A/E firms must have an affirmative process for managing and producing quality construction documents that combines both proactive and reactive efforts. Such efforts will be more effective if there is a unified strategy for achieving consistent quality assurance and quality control. Many firms have partial approaches that provide a level of quality management and are implementing some 'lean' procedures, but lack a comprehensive approach. There is no single solution and each firm must develop a plan for quality suitable for its size, staff, and project types. This session will discuss key concepts in managing quality and outline a practical approach for developing such a QA/QC strategy.

A major factor that affects both efficiency and quality is management of design decisions to ensure compliance with the owner's project requirements. Procrastination of project decisions is sometimes a matter of decision avoidance, but lack of planning is probably a more common cause. Whatever the reason, ill-timed and out-of-sequence decisions by the owner, the design team, and the construction team are always costly and can adversely affect the project schedule and the work of other project participants.

INTRODUCTION

Despite innovations in software technology for producing accurate drawing and specification documentation, the quality of contract documents for construction has been steadily declining. The authors as specification consultants for a large number of firms have a unique perspective because they view drawings from multiple sources across the country and have to deal with getting timely decisions on products and basic contracting requirements to provide specifications. We are deeply concerned that there is a coming crisis in construction document quality and are in the process of investing time and resources to develop tools that we believe could help project teams avoid this crisis.

Poor documentation has negative effects on all participants in a project:

Owners may be subject to excessive change orders, which in turn may affect their relationship with lenders, delay project completion, and disrupt planned revenue. Poor documentation may result in dissatisfaction by the people who occupy and use the completed facility, which in extreme cases can lead to legal claims. Most Owners do not have in-house technical staff to perform quality control oversight over the production process or the final set of construction documents. One of the authors of this paper has performed three peer reviews of documents for large, complex projects prepared by other firms to provide an independent, objective quality analysis for the Owner's benefit.

Although the Construction team can recover most costs for change orders, the cost of preparing such requests and preparing excessive numbers of Requests For Information (RFIs) and for extensive meetings to resolve ambiguities and mistakes in documentation come out of its basic fee, to say nothing of the effects of scheduling changes and frustration on staff.

Design teams have costs for working on change orders and answering RFIs and other field questions that come out of its basic fee and have negative effects on its staff with regard to frustration, interruption of other productive work, and overtime. Negative effects experienced by the Owner may result in not being considered for future work or even loss of reputation, thus resulting in loss of potential future income.

All projects inevitably have some changes and unforeseen circumstances that must be resolved during the construction period. Construction and Design teams include an estimated level of costs in their fees, but because most fees are stipulated sums the ability to recover costs that exceed those estimates is very limited. When excessive costs are the result of inadequate contract documents, the Construction team is in a much better position to recover costs than the Design team. Ultimately it is the owner that bears the risk of increased costs, delayed completion, and financial disruption.

Drawings today are almost universally produced on computers with two-dimensional CAD or three-dimensional BIM software, which make it all too easy to copy mistakes. At present, the output for contracting purposes are two-dimensional drawings, whether distributed as printed sheets or in electronic form. At some point Building Information Modeling (BIM) files may be used for permitting and contracting. Whatever the form of output, drawing errors and resulting re-drawing effort have multiple avoidable causes:

- Drawing ahead of decisions.
- Drawing elements out of sequence.
- Desire to impress the Owner with lots of paper.
- Lack of coordination of BIM views depicting relationships of objects; for example, reflected ceiling plans that do not show soffits at overhangs or stairs and escalators.
- Dimensions and other requirements that are not in industry-standard locations and therefore difficult for Construction team members to find, which is a source of unnecessary RFIs.
- Dimensions that are unorganized, hard to understand, and inadequate.
- Drawing without knowledge to draw elements correctly per industry standards.
- Lack of timely coordination with other disciplines, including missing provisions for drainage of canopies and other small roofs.
- Non-continuous or inadequate thermal barriers, which may not be coordinated with energy code compliance information.
- Lack of timely coordination with specifications, especially drawing note terminology.

Specifications and Contract Administration are two subjects that are generally not taught in a meaningful way in architectural and engineering colleges. In our experience, few people charged with these tasks supplement their formal education with reading books on the subject or taking supplementary courses since it is possible to pass registration exams without doing so. Although AIA general conditions state that drawings and specifications are at the same level of precedence, most lawyers and other people outside the A/E/C industry believe that specifications should take precedence over drawings and in event of a claim. Owner general conditions written by their lawyers state that specifications take precedence over drawings. Despite these facts, few architects and engineers expend the same level of effort in producing specifications as drawings.

Likewise, few firms of any size have an effective QA/QC program that is consistently followed. Many do not even have guidelines for time to be expended in QC reviews. A survey of QC reviewing at a large multi-office, multi-discipline firm by one of the authors discovered that most reviewers had less than one day to review drawing sets and less than half the time had access to specifications to verify coordination.

At the same time that design fees are declining, building design projects have been steadily increasing in complexity, there are increasing demands from Owners and Construction team to shorten both production time and response to contract administration tasks such as submittals, RFIs, change orders, and other decision documentation. This increase in complexity is a result of more complex regulatory requirements, technological developments, the increasing number of available construction products, and the visualization capabilities provided by BIM. It is the basic thesis of this paper that only those firms that develop and consistently implement a quality assurance and quality control program will be able to succeed in this environment. Many firms have partial approaches to quality and may be implementing 'lean' design procedures, but do not have a comprehensive strategic plan that is consistently used. Such QA/QC programs must be developed for the individual firm's size, staff, and areas of practice. This paper has broad stroke recommendations for developing a comprehensive quality management program to help design firms achieve their aspirations, satisfaction, and profitability, and to avoid costly claims.

ROOT PROBLEMS

Traditionally, Owner project requirements, summary of regulatory requirements relevant to the specific project, and the responses of the project team to those constraints have been in separate documents, which are often not available to all members of the design team that are making design decisions and product selections. Although it is common for privately-funded projects to select a general contractor at the same time or even before selecting an architect, there is often little input from the construction team at conceptual and schematic phases. Pricing and value adjustment is usually reactive and performed after the design team has prepared preliminary drawings and specifications, which then requires much re-work on the part of the Design Team and can result in significant schedule delays for the Owner.

As observed above, registration exams for architects, interior designers, and engineers do not verify proficiency for certain basic responsibilities necessary for protection of the public. Because colleges do not provide meaningful courses to prepare potential registrants for such tasks, it follows that design firms should have an organized educational program to make up for deficiencies in formal education. Learning how to make wise, informed decisions for planning production, product selection, and detailing are things that graduates are expected to learn through mentoring. The question is then whether design firms have effective programs for instructing staff in critical tasks that were not part of their college education. To be effective, a level of structure for such an educational process must be part of a Quality Management program.

It is ironic that architects and engineers require transparency from the Construction Team in the form of detailed construction schedules on behalf of the Owner, but seldom provide such information themselves for the design process. Planning project decisions, whether by the Owner, Design Team, or Construction team, should be part of production planning. In our experience, other than listing dates for various meetings and deliverables Design Teams seldom plan their work in detail. As a result, major decisions are often deferred to the Construction Documents phase, resulting in disruptions and re-work needed to change decisions to meet budgetary constraints or to coordinate with other elements. Such changes at late stages in the project have a profound ripple effect that affects multiple disciplines, impacts the schedule and complicated document coordination.

Interdisciplinary coordination and verification reviews are an essential subset of an effective overall QA/QC program, but is neglected when documents are reviewed in single discipline "silos." Crucial to the success of quality management is overlay comparison of drawings and use of checklists to check documents. William Nigro invented his RediCheck™ interdisciplinary coordination review process while a civilian employee of the Navy. Although primarily concerned with drawings, implementation of his methodology greatly reduced the number and severity of requests for change orders. Today the RediCheck™ firm has multiple offices that offer this specific service to Design Teams and Owners. As valuable as effective interdisciplinary reviews are, planning positive coordination activities is even more important and can save

valuable time. Successful coordination depends on clear communication of project design decisions so that all members of the Design Team have access to such information to base their own discipline decisions.

Many firms limit their Quality Management to producing drawing standards that, all too often, relate primarily to formatting rather than content. It is common that there is not a plan for periodic reviews of standard details, with the result that elements are depicted that do not meet current regulatory requirements or are impractical to build. Even when firms have a written QA/QC program, schedule pressures or lack of training in its implementation hinder implementation.

SOLUTIONS

A conceptual outline for a successful QA/QC program has four processes whose relationships are shown in the following conceptual diagram:

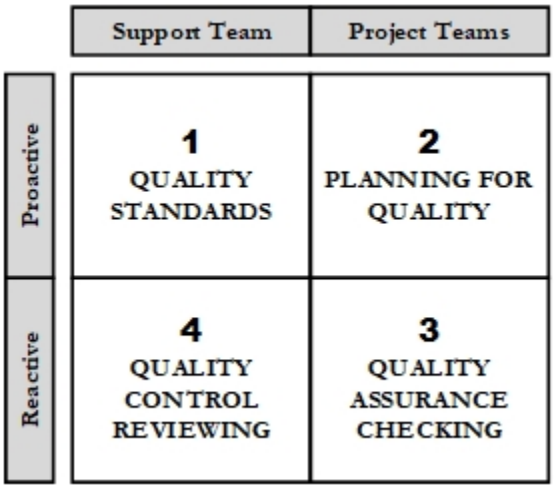

Figure 1 Matrix diagram of the relationship of essential processes for developing an effective QA/QC program.

Bullet items in the following quadrant descriptions are not exhaustive, but are offered as a starting point for discussions to plan and document a comprehensive, coordinated QA/QC program.

Quality Standards. The first quadrant covers identification of standards and training needed by the firm for stabling consistent content of construction documents. Firms need to document their corporate memory and what they aspire to be. All activities in this process should have regular reviews to identify things that need updating. A basic purpose of this quadrant is to establish a set of expectations needed to achieve appropriate levels of productivity and quality.

- Setting goals for each phase of design that relate to what decisions should be made in each design phase and what information should be included in deliverable for those phases.
- Setting office standards for formatting and location of information. As observed previously, it is not uncommon for younger staff to put information in non-standard locations where it is difficult for the Construction Team to retrieve for their purposes.
- Access to industry standards that include building and zoning codes, publications by standards-generating associations such as ASTM, and industry associations.
- Tools: BIM software cannot be used effectively in "out of the box" condition, but must be set up for the firm's needs.
- Training: As observed above, there are essential tasks for which college does not train students of architecture, interior design, or engineering. Such training should be systematic rather than relying on informal discussions at the water cooler.

- Developing and managing checklists for quality assurance checking and quality control reviewing.
- Sharing contact information for trusted advisors on construction methods and products.

Planning for Quality. Abraham Lincoln once said, "If you give me three hours to cut down a tree, I'll spend two hours sharpening my axe." Army training for officers includes the principle that the less time you have to accomplish a mission, the more time you need to spend planning. It is essential that a critical path of design decisions be developed and followed during production to avoid postponing difficult decisions, especially when projects are fast-tracked with more than one work package, as is increasingly the case.

- Analyzing regulatory requirements and other industry standards to document requirements for the specific client and project.
- Developing a critical path for priorities of design decisions and documentation.
- Identifying research needs and decisions.
- Tracking the value stream to avoid activities that do not contribute value to the project. "There is nothing so useless as doing efficiently that which should not be done at all;" Peter Drucker quoted in *Managing Quality in Architecture*. This is a basic concept of 'lean design.'
- Scheduling sufficient time for both QA checking by the project team and for QC reviewing by off-team staff. Charles Nelson in *Managing Quality in Architecture* states "The most common excuse for failing to carry out intended checking programs is that the team 'ran out of time.' "

Quality Assurance Checking. As indicated in Figure 1, this activity is performed by the project team itself and should always utilize checklists. Checklists should be developed as a Quadrant 1 activity. To ensure that the checklists are both short enough for practical use and detailed enough to be effective. All of us have seen detailed, 'micro-management' checklists that are too onerous to use. Checklists should following the Pareto Rule that 20% of issues cause 80% of the problems. Feedback from QC reviewers and contract administration staff should inform what items need to be included.

- Conduct multi-level checking. Simple checklists for different types of drawing sheets (plans, elevations, sections, details) can be developed so that the person primarily responsible for the sheet can check things like north arrows, scale information, and the like.
- Discipline-specific checking should utilize discipline-specific checklists, especially for architects who are checking consultant documents for coordination and completeness.
- Project team checking should have an early phase for initial groups of details and drawing note terminology to avoid the 'ripple' effect of copying mistakes throughout the documents.
- Interdisciplinary coordination meetings to check progress and resolve conflicts.

Quality Control Reviewing. Off-team reviews by qualified staff who can provide an objective look at the documents is an essential part of Quality Management. Charles Nelson in *Managing Quality in Architecture* states, "The person most likely to miss an error or omission is the person who made the error or "created" the omission. Conversely, the less a person knows about a project, the more likely it is that [a reviewer] will question things that don't seem quite right or quite complete."

- Provide sufficient time for reviews, both in terms of having enough hours to do an appropriate review and allowing sufficient time for the project team to respond to review comments. Although planning for review time is a Quadrant 2 activity, the firm should establish minimum review periods as a Quadrant 1 activity. Although project managers are often reluctant to provide enough time in today's accelerated schedules, improved planning can offset review periods and shorten the time needed for them. One large architectural firm requires project managers to certify that the documents, including specifications, are at a sufficient stage for QC review so that the reviewer is not doing detailed QA checking.
- QC reviews should be performed for each deliverable: Schematic Design, Design Development, and Construction Documents—including each work package. Phased reviews also make it easier to schedule sufficient review time.

- Identify a cadre of qualified staff with necessary skills and available time. Smaller firms may need to augment staff with reviews by an outside consultant. There are firms that specialize in such reviews and some specifications consultants offer this service. Not all senior staff are good at identifying things that should be in the documents but are missing, and, again, checklists are essential. Identifying "what is not shown, but is required" is often the greatest value reviewers can provide.
- It is not necessary for the reviewer to solve problems because most teams can do that themselves *if they see them*. To quote G.K. Chesterton, "It isn't that they can't see the solution. It is that they can't see the problem."
- QC reviewers should provide information to senior firm management on the effectiveness of QA checking.
- QC reviewers should provide feedback to Quadrant 1 staff for trend tracking and improvement of checklists.
- An essential QC task is to have a permanent record that the project was reviewed according to the firm's requirements. In the event of a claim, this record is critical evidence that due diligence was followed and establishing conformance to standard of care. The authors advocate destruction of documents with review comments and checklists to avoid unnecessary 'second-guessing' about review findings. What is important is that a design firm can demonstrate it followed its own internal standards (which implies that a written QA/QC program exists), but how many firms can do that?

CONCLUSIONS

Continuous Improvement: A QA/QC program should have provisions for learning from experience. Some firms issue "Lessons Learned" technical bulletins and have a library of them. All the factors that go into the present level of complexity of building design projects will continue to increase, and design firms must learn how to turn experience into improvements both for quality and productivity.

Fred Stitt of the San Francisco Institute of Architect, who has written several books on productivity, has found in his research that over half the time expended on an average architectural drawing sheet is used for *redrawing*. Although not explored in detail in this paper, design firms need to eliminate both redrawing and unessential things from drawings and specifications. In our experience most sets of drawings have notes, dimensions, and even whole details or sections that are not needed by the Construction Team to build the project, while at the same time essential information is missing. A basic tenet of the 'lean design' movement is eliminating waste by tracking the value stream. Why have notes to identify products inside a reference bubble that duplicate notes in the referenced large-scale detail?

Collaborative Decision Management:

As stated above, a major factor in collaborative decision management is the fact that Owner requirements and other planning documents are generally multiple documents rather than a progressive stream of information located in a single location that is available to the Owner, Design Team, Construction Team, and other stakeholders. One of the authors while leading a peer review of construction documents for a new major hospital used the 30+ page Owner Project Requirements document to create a review checklist to verify that the Owner's expectations would be met. The review team found that only about 2/3 of the requirements were implemented in the design, which likely was a result of the fact that it was a separate document rather than being integrated into the design planning process.

Conspectus, Inc. promotes rethinking specifications as a quality assurance and quality control tool to serve a project from inception through operations. Specifications are more than the MasterFormat based construction specifications. Instead, they are all the non-graphical project requirements, including owner project requirements, regulatory requirements, design criteria, and the designed solutions. Specifications are essential data that are used to measure the Design Team's response to the problem the owner wishes to solve.

The concept is founded on UniFormat, a hierarchical classification standard arranged by systems and assemblies. This same classification can function as a QA planning tool to develop project team responsibility matrix, decision checklist, and level of development for each project phase. Plus employing UniFormat allows drawings via BIM, specifications including Owner project requirements, and estimates, the three principal factors governing project development to be unified and coordinated from the beginning. When documentation is consistently organized by a recognized standard, the entire team will benefit from the well-coordinated documentation.

To support this approach, Conspectus is developing a new cloud-based tool. This new tool will allow proactive participation by all stakeholders via a transparent process that documents project requirements beginning "day one" and continuously builds the project record in a single location as information becomes available and decisions are made. The information gaps and data loss that occur between design phases each time new documents are created are eliminated. The tool will track the progress, alert missing critical information, collect comments, and record the history as the project progresses. All the while, each stakeholder can watch and actively contribute to the specifications development.

This tool can record Owner project requirements, proposed design solutions by the Design Team, and constructability and budget information from the Construction Team in a single, truly collaborative setting so that essential decisions are not postponed with negative effects on Owner satisfaction, schedule, and construction document production efficiency. Because decisions are documented and dated, all stakeholders can be confident in their reliance on the information.

At the appropriate time, the information is re-sorted into MasterFormat classification for production of contract specifications so project requirements are not lost or forgotten. The tool automatically populates construction specifications with a level of information that makes final editing of specifications easier and less time-consuming.

Summary: The increase in complexity of design is not going to decrease. To avoid claims, be profitable, and meet internal aspirations and staff satisfaction, a conscious approach to Quality Management is essential. Firms that do not have adequate QA/QC programs that are consistently implemented are vulnerable to claims and excessive internal production costs. Anecdotally, our experience with construction drawings from design firms of all sizes throughout the country is that the quality of drawings is steadily decreasing and we are concerned that this trend will reach a crisis level.

Each design firm must develop a comprehensive Quality Management program appropriate to its practice. There are many other aspects to Quality Management that are outside the scope of this paper, including business management and evaluation of potential clients. This brief paper is offered in the hope that it may motivate design firms to develop suitable programs for their firms and that suggestions offered herein may help such firms determine what may be missing or under-developed in their Quality Management.

With a conscious effort, the industry can dispell the opinion held by many and clearly expressed by Hal Barcus, one author's architecture professor, "Architecture is never done. You just run out of time, patience, or money." Architecture must be done, and done well with established Quality Management System to fulfill the owner's project requirements.

Nomenclature

Owner: The entity contracting for the design and construction of a facility, whether for its own use or as a developer for sale or lease to other end users.

Request for Information (RFI): A written request by the Contractor for clarification or interpretation of contract requirements, or for needed additional information.

Design Team: The architect, interior designers, engineers, and various other consultants who prepare the contract documents for construction. For building construction projects, most Design Teams are led by an

architectural firm who fulfills the coordination responsibilities of the building code for what the International Building Code terms the "design professional in responsible charge of the project."

Quality Management: The organization, implementation, and supervision of quality assurance and quality control processes in a coherent program that is effective to provide the level of quality for deliverables that meets legislative requirements for registrants to protect the public, provides Owner satisfaction, and meets the firm's goals and aspirations.

References, Bibliography

Charles Nelson, AIA, FRAIA; *Managing Quality in Architecture,* Architectural Press; copyright ©2006.
Glenn E. Wiggins, AIA; *A Manual of Construction Documentation;* Whitney Library of Design; copyright ©1989.
Andrew J. Civitello, Jr; *Contractor's Guide to Change Orders;* Prentice-Hall, Inc.; ©1987.
Michael Czap; www.leanarchitecture.com website.