



# The Integrated Quality Process in the Built Environment

Originally Published April 20, 2017 by the CQEC

Updated February 7, 2024 by the DCX Quality Exchange

## The Language of Construction Quality

As was introduced in the *Language of Construction Quality*, one can use a Quality Map to compare quality programs between key project stakeholders and identify how well the quality programs are aligned (or not aligned). An example of the Quality Map and alignment items are shown in Figure 1 below.

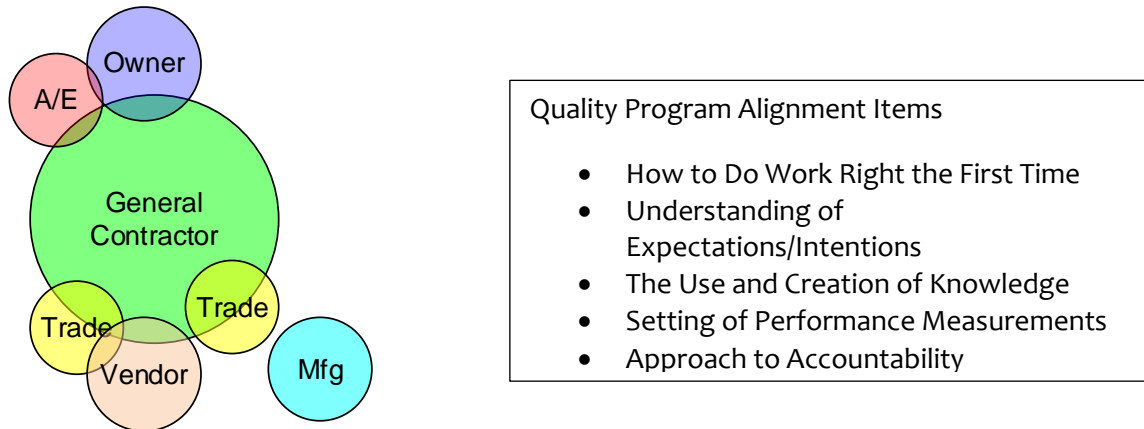


Figure 1: Quality Map and Alignment Items

In addition, several Quality Program Core Elements and Contributing Factors were introduced:

| Quality Program Core Element      | Quality Program Contributing Factor |
|-----------------------------------|-------------------------------------|
| Preventative                      | Planning                            |
| Predictive                        | Skill                               |
| Continuous Measurable Improvement | Schedule                            |
| Collaborative                     | Resources                           |
| Individual                        | Alignment/Behavior                  |

While these are all important and foundational to understanding the quality process in the built environment, there was not sufficient guidance given to help those new to quality in design and construction to help them create or improve their individual quality programs.

Therefore, the purpose of this publication is to identify and convey what is the overall Quality Process in the built environment and guidance on how to translate the general Quality Process to your specific Quality Program.

## Quality Process in the Built Environment

While there are many approaches to design and construction quality (US Army Corps of Engineers, Lean Construction Institute, Total Quality Management, Six Sigma, etc.), these have typically been at the direction of an owner through a project contract (procedural based) or ad hoc adoption by a design or construction company based on conferences, papers or other communications. The challenge with these quality approaches is that they often do not align with the core culture of the design or construction company and are not integrated into the way a company executes their work on a day-to-day basis (regardless of the contract requirements).

For a Quality Process to be successful in a design or construction company it has to just be the way they operate, not a layer within the organization or an add-on when they are being paid to do it – you

do it because you know the investment of time and money is less than the pain and suffering if you skip the step.

A classic example of this in construction is that of physical mock-ups. Many companies will just do the mock-ups dictated in the project contract and no more. Those with an integrated Quality Process will always do the relevant physical mock-ups, as early as possible, to identify and eliminate risk to their company and the other project stakeholders – this includes constructing and fully testing a building enclosure mock-up during the design phase to ensure proper details are integrated into the design the entire team knows are constructible and perform in accordance with the owner expectations.

You can also probably identify something in your personal life that you invest in, regardless what is considered minimum requirements, as you know it is best for you. This could be the food you buy, the way you travel, or education for your kids – think about it and see if you can identify a personal quality-based item you invest in.

### Moving from Language to Process

So the obvious question to answer is how do we go from the Language of Quality to that of the Quality Process? While we could just jump to the traditional definitions of a quality process, we have found that this does not make it personal and sustaining within an organization. Therefore, we need to better understand how design and construction companies operate, why they are in business and how quality aligns with that. Figure 2 is a generic representation of this.

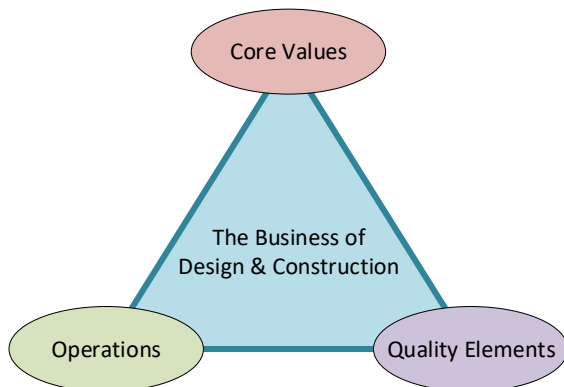


Figure 2: A Construction Company

The first step is to understand what is the “Business of Design and Construction”. Simply put, the Business of Design and Construction is for a company to make money (profit) by managing and physically designing the project for design companies, and managing and/or physically constructing a project for construction companies. There are a lot of ancillary items that a company needs to get right to be successful, but ultimately, if they do not make money, they do not stay in business. Therefore, it is important to develop and align quality processes around this core business purpose.

However, it is not simply about making profit, you also need to look deeper into the company and understand their core values and how they operate in order to translate the Language of Quality to a Quality Process. While every company is unique in their core values, and use different terms, the most common ones across all design and construction companies are:

- People – the project stakeholders are the ones that get the work done, so focusing on a company’s people and associated stakeholders is often key to how the company operates and behaves.
- Experience – this core value often deals with the “Project Experience” – how everyone interacts and collaborates throughout the project, as well as to the specific technical and process experience the team members bring to the project.
- Safety – keeping everyone safe and doing work right the first time (the first time is always the safest way) is foundational to all construction companies due to the risk of injury and death on each and everyone of our projects. This is important, but not always primary, to the design company as the design determines how safe the construction can be and they have employees on the project during construction.

A challenge with core values is that they are good to understand and are fundamental to a company, but do not get to the how a company operates – this is where Operations comes into play. Operations are the written (and unwritten) policies and procedures used within a company on how they execute their work. This can be for both internal operations (employee advancement) and external operations (processing a submittal). Every company has an operation approach to their projects, some more formal than others. What is important to understand is how the Business of Construction (profit) and Core Values flow into operations and are reinforced through their processes.

In our journey to a quality process, it is important to pause at this point to recognize that any discontinuity between a company’s core values and the way they operate will cause friction and make it challenging for the company to go to the next level of an integrated quality program. You must first address and fix any discontinuity before moving forward. A classic example of this is often with respect to people, the project experience and profit – when these do not align at the company and project level, there will be problems. For example, if a company needs x% profit to be viable, yet continually bids and takes work at (x-1)%, their operational behavior contradicts that of core value, putting their people and project experience at risk.

The final step prior to getting to a Quality Process, is to address the Quality Elements with respect to the Business of Construction, a Company’s Core Values and their Operations. To be sustainable and thriving within a company, the quality process must be integrated into all of these, not an add-on activity or layer within the company. The following table provides an understanding of how you can go through this for your company.

| Business Element   | Quality Elements |            |                                   |               |            |
|--------------------|------------------|------------|-----------------------------------|---------------|------------|
|                    | Preventative     | Predictive | Continuous Measurable Improvement | Collaborative | Individual |
| Profit             |                  |            |                                   |               |            |
| People             |                  |            |                                   |               |            |
| Project Experience |                  |            |                                   |               |            |
| Safety             |                  |            |                                   |               |            |
| Operations         |                  |            |                                   |               |            |

While there is a lot here to absorb to be able to translate to a quality process, a good way to distill the key information is to remember the following key items:

- Integrated – the quality process activities are just what people do – they don't even have to be identified as quality items if that makes it easier for implementation, but they have to be accomplished.
- Expectation Management/Alignment – quality and success of the project is all about understanding and managing client and stakeholder expectations – any misalignment results in additional work and more grief between stakeholders.
- Transitions – the quality process does not end – it spans project transitions to maintain cohesiveness and continuity (design to construction and construction to owner operations).

### The Quality Process in the Built Environment

As you can probably tell by now, defining what the Quality Process in the built environment is not all that easy, and thus had not been done until now. As you go through this section, you will see that many of the design and construction companies you deal with have some, if not all of the key phases and activities identified, but just don't have a cohesive Quality Program in place.

Figure 3 provides a graphical representation of the DCX Quality Exchange Integrated Quality Process (IQP) in the Built Environment.



Figure 3: The Project IQP

Before going forward, it is important to remember that the IQP is adopted by design and construction companies as their way of operating, regardless of contract requirements – this is the only way to be best-in-class and have a robust quality program. Further, the terminology used in the IQP is intentionally generic – changing the verbiage to company specific does not change the quality process, it just makes it personal and yours.

Let's start with the nine phases of the IQP, with the first four being primarily design phase focused, the last four being primarily construction phase focused, and the fifth being the transition between design and construction.

1. Owner Expectations – the start of any quality process is to understand the expectations needed to be met for success, which in the case of the built environment are the Owner Expectations. This first phase is defining, prioritizing and maintaining the Owner Expectations throughout the entire project.
2. Design Quality Planning – foundational to any quality process is understanding what you are doing and where you must focus your time to be successful. While at the beginning of the design phase, Design Quality Planning is actually a living, on-going activity throughout the design phase to maintain appropriate focus on quality.
3. Designer Certainty – the third phase is the alignment and management of expectations with all of the project's design professionals. The goal of this phase is that every Design Professional understands and is aligned around their scope of work, how they will execute it, interactions with other Design Professionals and especially how the team will verify success.
4. Verification of Design – checking the work is being accomplished properly to achieve the Owner Expectations is a must of any quality program. This is not a one-time item, but integrated into the day-to-day activities of every design professional. They know what they are supposed to do, what success is, and they document it was done right the first time.
5. Construction Transition – a specific phase to transition from design to construction is critical to a successful quality process as this transition is where information and momentum can be lost, as well as a shift of focus from Owner Expectations to contract documents.
6. Construction Quality Planning – just as with Design Quality Planning, Construction Quality Planning is foundational for the construction personnel in understanding what you are doing and where you must focus your time to be successful. While at the beginning of construction phase, Construction Quality Planning is actually a living, on-going activity throughout the project to maintain appropriate focus on quality.
7. Trade Certainty – this phase is the alignment and management of expectations with all of the project's Trade Partners. The goal of this phase is that every Trade Partner, and the project key stakeholders, understand and are aligned around what the scope of work is, how they will execute it, interactions with other Trade Partners, and especially how the team will verify success.
8. Verification of Installation – checking that work is being accomplished properly is a must for any quality program. This is not a one-time items, but integrated into the day-to-day activities of every individual on the project. They know what they are supposed to do, what success is, and they document it was done right the first time.
9. Owner Operation – the final phase in the IQP is the transition from building the project to the owner operating it. This will obviously vary based on project complexity and the owner, but it is important to recognize that the Quality Process continues well into Owner Operation in order to capture lessons learned and continuously improve the construction process based on what doesn't work for the owner.

One item to note before we dive into each phase – you should note that the word “Quality” is not used much in describing the IQP, and could actually be removed from the phases all together. This is intentional in that we want the Quality Process to be integrated into a design or construction company's operations, supporting their Business and Core Values.

## Owner Expectations

Owner Expectations are actually captured very well on most projects during the design phase. The difference between what is currently being done and that in a robust quality process, is that the Owner Expectations are maintained throughout the entire process as the primary focal point – continually referred to by all project team members to maintain their focus on success and that the reality shown in the design or construction actually matches the expectations.

- Success Criteria – identifying and documenting the success criteria on a project is accomplished many different ways, such as design charrettes, owner workshops, surveys, and even past experience (owner design manuals). Regardless of how the criteria is obtained, what is important is it is put in a format that can be utilized and referenced throughout design and construction.
- Key Owner Expectations – in reviewing the documented success criteria, a best practice is to identify recurring items and pull them out as Key Owner Expectations. These are the success criteria that ultimately drive the overall success of the project and if compromised will be a detriment to all team members.

## Design Quality Planning

There is a massive amount of planning accomplished on any design project, ranging from personnel, to meetings, to the flow of work. To be truly successful on your project, Design Quality Planning is integrated into the overall (and on-going) project planning process. The difference with Design Quality Planning compared to other project planning activities, is that each project is unique on the focus – to match the uniqueness of the project, and more importantly the quality risk on the project.

- Identify High Risk Items – the first step in Design Quality Planning is for the Project Team to collaboratively identify the high risk items which could compromise the final project (upon turnover to the owner) quality if not addressed and mitigated early in the project.

In order for a Project Team to be able to identify their high risk items, they must first understand the project, team members and scopes of work. This means a thorough review of Owner Expectations and knowing who the key project team members are during the design phase.

Examples of high risk items range from personnel issues (appropriate and skilled staffing) and schedule/budget (sufficient time and money to complete scope of work) to technical issues (can we design it to then build it) to material concerns (will the material perform).

It is best for the Project Team to identify, maintain and mitigate their high risk items – continually changing throughout the design phase to address the current and near term risks.

- Living Quality Plans – the key to the on-going successful implementation of a quality process is that the project specific quality plan is living. This means that it is constantly updated and used by all project personnel to do their day-to-day jobs – they are aware of the high risk items, how the risk is being mitigated, and who to work with when new issues are identified.



For the Design Quality Plan to be living, it must be quickly understandable and usable by all project team members. A best way to achieve this is to avoid using narrative, “book-like” quality plans and only use 1-page Quality Plans. The 1-page format allows you to maintain the appropriate focus through maintaining current status and level of information.

- Pre-Emptive Planning – however, just identifying the risk is not enough, the individuals responsible for mitigating that risk need to be aligned on their plan to overcome the risk. Therefore, for each risk item, the team responsible needs to go through a formal pre-emptive planning process which applies the appropriate level of quality activities to the level of risk.

A good way to understand this is to look at the level of verification applied based on the risk of an item. For example, in a simple warehouse, the level of verification needed to be confident the heating and cooling works is relatively low. However, when you look at the same type of system on a nuclear submarine, there is likely 5-20x the level of verification to be applied.

Therefore, through pre-emptive planning, the project team collaborates to identify how the quality process is specifically applied to that scope of work (risk) so that it is done right the first time.

### Designer Certainty

On most projects you do not start with the entire design team fully formed and working from day one. In reality, you start with a small core team and add new team members, specialists and consultants throughout the project as the design is developed and finalized. In this phase, Designer Certainty is ensuring that the individual designers and design teams (clusters) are ready to start their specific scope of design and understand how to achieve success.

- Team Formation – the on-boarding and formation of the team during the design phase is typically ever evolving. What is important from a quality process perspective is that there is a pause as each design phase (scope of work) is started to review the Owner Expectations and how the expectations will be achieved through the design scope.
- Basis of Design Planning – once the Owner Expectations are understood, the design team should then discuss how they will achieve the expectations through the design process – how they will develop and document the Basis of Design for the scope of work. A best practice is the designers present their plan to the larger project team to gain alignment and understanding.
- Design Phase Mock-ups – a critical aspect during the design phase is to gain an understanding and alignment that the high risk items can be properly constructed to perform to achieve Owner Expectations. Consideration should be given to physically constructing key mock-ups to prove performance and getting proper details in the design documents. A great example of this is the building enclosure mock-up and fully validating performance through a negative air-water test.

## Verification of Design

Throughout the design phase it is essential that the individual design professionals and the overall team verify the design is achieving the Owner Expectations and aligns with how the project will be constructed for optimal efficiency and effectiveness.

- OE/BOD Comparison – a key tool for accomplishing this verification is for the design professionals to clearly state their Basis of Design (BOD) for each Owner Expectation (OE). A best practice is to accomplish this via a spreadsheet and reviewing as part of each package submission.
- Constructability – throughout the design process it is essential to obtain input from construction professionals on how they plan to construct the project and integrating constructability insight into the design to make the overall construction process streamlined.
- Mobilization Planning – similar to constructability review, it is important to discuss mobilization planning with the team and constructional professionals to understand and plan for mobilization and how the non-built environment items (e.g., trailers, cranes, laydown, etc.) are accomplished throughout the project.

## Construction Transition

A critical, yet often overlooked, phase is the transition to construction. As the design team winds down and the construction team winds up, there is often a loss of focus and understanding of success for the project. A smooth transition through this phase is essential to overall project success.

- Trade Buyout – the identification, prequalification and buyout of each trade is critical for success and avoiding gaps in scope and ensuring the selected trades can perform appropriately.
- Expectation Alignment – the use of the Owner Expectations/Basis of Design is a great way to maintain expectations and achieve alignment. This can be used throughout the onboarding process to go beyond traditional design documents and specifications.

## Construction Quality Planning

There is a massive amount of planning accomplished on any construction project, ranging from personnel, to materials, to the flow of work and safety. To be truly successful on your project, Quality Planning is integrated into the overall (and on-going) project planning process. The difference with Quality Planning compared to other project planning activities, is that each project is unique on the focus – to match the uniqueness of the project, and more importantly the quality risk on the project.

- Identify High Risk Items – the first step in Quality Planning is for the Project Team to collaboratively identify the high risk items which could compromise the final project quality if not addressed and mitigated early in the project.

In order for a Project Team to be able to identify their high risk items, they must first understand the project, team members and scopes of work. This means a thorough review of contracts, plans, specifications and knowing who the key project team members are.

Examples of high risk items range from material concerns (will the material perform), design issues (can we build it), to personnel issues (appropriate and skilled staffing) and schedule/budget (sufficient time and money to complete scope of work).

It is best for the Project Team to identify, maintain and mitigate their high risk items – continually changing throughout the project to address the current and near term risks.

- Living Quality Plans – the key to the on-going successful implementation of a quality process is that the project specific quality plan is living. This means that it is constantly updated and used by all project personnel to do their day-to-day jobs – they are aware of the high risk items, how the risk is being mitigated, and who to work with when new issues are identified.

For the Quality Plan to be living, it must be quickly understandable and usable by all project team members. The best way to achieve this is to avoid using narrative, “book-like” quality plans and only use 1-page Quality Plans. The 1-page format allows you to maintain the appropriate focus through maintaining current status and level of information.

A primary reason the 1-page Quality Plan works so well in a robust Quality Process is that details (procedures) on how to accomplish something are integrated into a company’s operations – it is not another layer, it is just what is done.

- Pre-Emptive Planning – however, just identifying the risk is not enough, the individuals responsible for mitigating that risk need to be aligned on their plan to overcome the risk. Therefore, for each risk item, the team responsible needs to go through a formal pre-emptive planning process which applies the appropriate level of quality activities to the level of risk.

A good way to understand this is to look at the level of verification applied based on the risk of an item. For example, in a simple warehouse, the level of verification needed to be confident the heating and cooling works is relatively low. However, when you look at the same type of system on a nuclear submarine, there is likely 5-20x the level of verification to be applied.

Therefore, through pre-emptive planning, the project team collaborates to identify how the quality process is specifically applied to that scope of work (risk) so that it is done right the first time.

## Trade Certainty

The next major phase is getting our Trade Partners on-boarded and aligned with how they are executing their work. There are a lot of ways to do this and ultimately it is up to the company and project team to determine the process. What is important is a company decide the critical aspects and hold their people accountable to making sure the Trade Partners are truly on-boarded and ready to do their work right the first time.

- On-Boarding – it is essential that your Trade Partners be on-boarded to each project uniquely, as each project is unique on their requirement and risks. On-boarding should include a clear understanding of contractual (contract, plans and specs) requirements, as well as the expectation of the Trade Partner. This must go beyond the Safety Orientation and get into

the details of personnel, submittals, verification procedures and day-to-day quality focused activities.

- Submittals/RFIs – while often not considered a quality activity, the processing and approval of submittals and RFI's (requests for information) are essential to the full on-boarding of our Trade Partners. The reason for this is that the submittals and subsequent RFI's define the scope of work and verification approach. The focus from the quality program perspective is not just getting approval of the submittals and resolution of the RFI's, but to ensure all project team members are aligned on the final solution, as well as agreeing up on what "success" is.
- Installation Planning – once a Trade Partner is on-boarded, in addition to submittals and RFI's, they need to go through a formal Installation Planning Process – where they plan and convey back to the larger project team how they plan to execute their scope of work. The key to this is that the Trade Partner highlights their key concerns (contract requirements) and how they will overcome those concerns through quality activities (i.e., mock-ups, testing, verification, training, etc.). The final step of Installation Planning is convening the Pre-Installation Meeting where the Trade Partner presents their plan.

At the end of Installation Planning, the Project Team should be aligned on how they will verify work was done right the first time.

### Verification of Installation

Once construction commences, the next phase is the verification of installed work. This is both an initial and on-going process.

- 1st Installation – there needs to be a pause after the first work is put in place to use the procedure and criteria established during Installation Planning to verify the work was done right the first time. Included in this pause is any time required for testing or resolving issues before the Trade Partner is allowed to go into full production.

It is important that the team be flexible on the 1<sup>st</sup> Installation Verification and be willing to change the way work is being accomplished and verified to both streamline the process and provide a better result for the project.

- On-Going – once the Trade Partner is into production construction, they are responsible for on-going verification of their work (at a minimum daily). This verification should be done at the crew level – those doing the work, and followed up (checked) by management/supervision.

Any issues identified should be analyzed and the approach to installation/verification modified to avoid further occurrence of the issues.

- Testing and Inspection – all projects have contractual testing and inspection requirements – which are activities completed at a point in time to verify the work meets codes, standards and contract requirements. These are critical to the project success, but it must be understood that any issues identified during testing and inspection is a failure of the quality

process, as the issue should have been identified and mitigated during Quality Planning, Trade On-Boarding and Verification.

From a quality process perspective, what is important for testing and inspection is to address failures aggressively to change the way work is being accomplished to avoid further failures. We must continually learn from any issue.

Also, the project team should not just do what is dictated in the contract documents, but look at the quality risk (Quality Planning) and do additional testing when merited.

## Owner Operation

The final phase is transitioning the project to the owner to operate. The primary goal of this phase is to learn from issues that an owner deals with and change your processes on future projects to avoid.

- Start-up – the most complex portion of almost any project is the start-up of it's systems – be it mechanical, electrical or other. Quality plays a key role in start-up in that it is often high risk and late in the project. The focus needs to be on proper coordination between Trade Partners and the Owner's Operators, as well as identifying key items for on-hands involvement by the Owner's Operators in the process.
- Training/Turnover – as part of the start-up, the project team needs to identify the key training to be accomplished and how the systems will be formally turned over from the contractor to the owner. A critical part of this is to identify the skill of the Owner's Operators and the skill needed to operate the systems effectively. Any gap must be filled vial training and hands-on experience.

The training program therefore must be tailored to the specific project and specific operator skills, not generic manufacturer training.

- Warranty Management – the final step in the Quality Process is the on-going management of the warranty process for the owner. The contractor needs to have a robust system to report, track and resolve any warranty issue.

Just as important as resolving the issues is to learn from the issues. Therefore, the contractor needs to analyze the warranty trends on an on-going basis and feed the results into their quality program, with the intent of reducing repetitive issues over time. See the *Quality Metrics* publication for additional details on tracking quality metrics.

## Quality Process to Quality Program

The IQP is meant to be applied and customized at the project level. While this provides great value to the project and the participants, the true value is to expand from the project (process) to the company (program).

For a Quality Program to be successful requires several key elements:

- Leadership – for a Quality Program to be successful, you need leadership for the program as well as support of the company's senior leadership to fully adopt and integrate the Quality

Process into the way they operate. This leadership is not about creating a quality layer within the company, but to integrate it into the company's culture.

- Behavior – the primary focus of the Quality Program is not on policies and procedures, but the behaviors the employees and project team members exhibit. The behaviors to reinforce are the Quality Core Values of Preventative, Predictive, Continuous Measurable Improvement, Collaborative and Individual.
- Metrics – the Quality Program needs to be driven by metrics to focus your project teams on the highest risks to the company as well as metrics to evaluate on-going operations and focus on the critical items for success.