A recipe for quality

Ashim Parmar, COIM, USA, alongside Alan Lloyd and Goutam Shahani, ShureLine Construction, USA, delve into the elements needed to provide consistent quality throughout construction projects.

Total quality management, Six Sigma, and Lean are well known in manufacturing and service industries. The quality concepts pioneered by Crosby, Deming, and Duran are geared towards bringing value to customers. This is achieved by integrating people, work process, and systems to consistently meet or exceed customer satisfaction. The concept of quality is equally important in construction. Delivering consistent quality in a construction environment is usually more challenging than in manufacturing. This is due to the fact that construction is not a repetitive activity in a controlled factory setting. Construction involves a variety of labour skills that need to come together, and various factors can add to the challenge, including different materials with quality checks, uncertain weather conditions, and demanding budget, scope, and schedule constraints. Furthermore, labour turnover is often higher in a construction environment, and safety is an absolute necessity. Construction hence requires more complex managerial skills. This article will review the important elements of an integrated quality management programme and provide examples of quality construction.

Elements of quality management

Performance can be defined as a balance of safety, quality, and productivity. It can be depicted as three connected gears in a machine. All three of these gears are equally important and have to work smoothly for the machine to work successfully. This is especially true in today's business environment, where projects are becoming increasingly complex with aggressive cost targets and demanding schedules, leaving little room for error. Safety can never be compromised as it is a necessary condition for all customers. Success in business naturally follows from strict adherence to safety and quality.

Customer

A good quality programme starts with the customer. It is important to understand what the customer wants and is willing to pay for. Most customers focus on a competitive price, others want a short construction schedule, while others may want flexibility. Customers usually demand high quality and safety as given. However, it is important to understand what is really critical to the customer and what they are willing to pay for. A hierarchy of factors needs to be considered – the customer priorities are generally safety, competitive cost, minimum change orders, compressed schedule, and detailed documentation, or a combination of the above. Continuous feedback from the customer before, during, and after project execution is essential to ensure customer expectations are being met.

Figure 1. Evolution of quality management.

Leadership

Leadership is a critical success factor for total quality management. Senior management has to generally provide a vision for quality. Furthermore, the necessary investment in time and money for quality management has to be made. Poor quality is usually not the fault of the machinery, workers, or raw materials. Instead, it could potentially be management not providing the right equipment, training, and work processes to deliver the desired results. Compromised quality adds cost, causes delays, and leads to safety incidents. It can ruin the reputation of a contractor and compromise the operation of the owner/operator. It is therefore essential for management of both the end user and the construction company to build a culture that emphasises quality management.

Culture

A company's culture takes a long time to form. Such a culture has to be carefully nurtured and sustained. Priorities, work processes, and values have to be established and sustained. Employees have to buy into a total quality management programme. Such a culture does not develop automatically. Instead, management has to carefully craft the message and constantly reinforce it. Roles and responsibilities need to be established. Necessary training and resources have to be provided. Rewards and recognition have to be given periodically to keep the team motivated. A dedicated quality manager, who is empowered and has authority over the entire organisation, must be appointed. This individual can be located on-site or based remotely with frequent site visits.

Education and training

In order to sustain a quality culture, it is necessary to have ongoing training for all employees. Education and training for craft and supervisory labour includes ongoing monitoring and corrective action. This includes hands-on training for actual crafts, such as welding, grinding, and cutting. This is supplemented by mentoring and practice in the shop. Lessons-learned sessions are rigorously completed after every project, with active feedback from clients to ensure continuous improvement. Tools such as Pareto analysis, a fish-bone diagram, 'plan-do-check-act', and root cause analysis are important and should be considered for use.

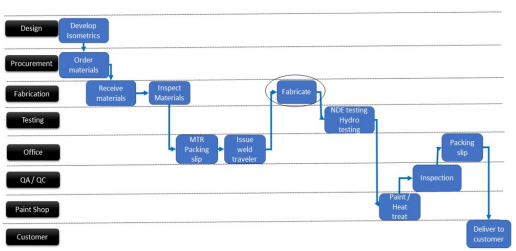

Figure 2. ShureLine QA/QC flow chart.

Teamwork

Teamwork is an essential tenet of a good quality programme. Roles and responsibilities must be clearly defined and good performance has to be rewarded in a timely manner. Every team member has to be aligned to a common team objective. Rewards and recognition are important to keep the team motivated. Communication should be horizontal and frequent. Documentation is necessary and a central repository, preferably digital, should be created for every project with easy access provided for all team members.

Total quality management in construction

In the manufacturing and service industries, the notion of quality has evolved over the last 50 years. This is depicted in Figure 1. In its early years, quality consisted of an inspection that was carried out to ensure a product or service conformed to specifications. If specifications were not met, the product was not sent to the customer. Inspection was done after the fact, which could result in wastage of time and money. For construction industry applications such as process piping, the testing is usually non-destructive and includes liquid dye, radiography, ultrasonic, and acoustic testing. Consequently, as stated earlier, it is important to have a trained skill set to perform work which steers towards a 'right first time' approach and minimising reworks.

Figure 3. Specialty chemical plant expansion.

Quality control, quality assurance and total quality management

The terms quality control (QC), quality assurance (QA) and total quality management (TQM) are often used collectively and interchangeably. However, there are important differences between these terms.

The concept of QC is based on periodic observation of actual performance. The actual performance is compared to standard, and the necessary corrective action is then taken. QC identifies defects after the product is produced but not yet released to the customer. In this way, if there is a defect, customer satisfaction is not compromised. However, this approach does not prevent defects from occurring in the first place. For QC to be effective, there has to be a commitment to produce defect-free product by adopting a proven workflow process.

QA involves establishing internal policies, procedures, standards, training, and systems to ensure product quality. QA influences QC as well. The focus is on internal work processes, so that defects do not arise in the first place. It requires considerable investment in time and money, but the pay-off is commensurate to right first time.

A written QA and QC plan ensures customers' expectations are met. In a TQM approach QA and QC go hand-in-hand. It entails well-known tools such as root cause analysis and Pareto charts to identify defects and take remedial action. The mindset must change from one of monitoring (QC) to continuous improvement (TQM).

Case studies

The principles and work practices for a TQM programme are the same whether the project is a small piping fabrication job or a multi-million dollar grassroots project. Once TQM is adopted at a company, it becomes a way of life. Small and big projects follow the same work process and discipline. A schematic showing the major activities in a 'swim plane' chart is presented in Figure 2.

It can be seen that the delivery of a simple pipe spool is much more than simply the fabrication depicted in the centre of Figure 2. There are a number of activities that go before and after the actual fabrication. Each step – from design, procurement, testing and QA/QC – has to be completed rigorously and in sequence to ensure complete customer satisfaction at the end. Ideally, in a partnership arrangement, the construction contractor can go above and beyond the customer's expectations. This may include carrying out a value improvement exercise given the contractor's familiarity with costs and constructability. For example, when the isometric drawings are being reviewed and before fabrication is started, it is worthwhile for the fabrication team to identify possible improvements in pipe routing. This will reduce the number of bends in a pipe. Such a value improvement will reduce pressure drop in the pipe and reduce the overall project costs for the customer. This builds confidence with the owner/operator

Figure 4. Pipe spool fabrication in shop.

Figure 5. Large diameter stainless steel pipe fabrication.

Figure 6. Skidded plant in shop.

and leads to a win-win for both parties.[1,2] Such an approach also raises the bar for the design team to further improve their work process and design deliverables.

Large chemical plant expansion

COIM, an international specialty chemical company, decided to significantly expand its production capability in West Deptford, New Jersey, US.[3] Quality was an underlying tenet for both COIM and ShureLine, and safety was every project personnel's objective. It was essential to complete detailed engineering to minimise scope changes and change orders. Decisions were made quickly based on available data, and team members were empowered to act decisively. Partnerships were formed based on capabilities, cost, and culture, and communication was open, frequent, and horizontal to avoid surprises. Figure 3 shows the piping in a small section of the overall project.

Smaller projects

A large project, such as the COIM project discussed, is composed of smaller sub-projects and tasks. An example of a pipe spool fabricated in the shop is shown in Figure 4. This pipe spool is made from schedule 10 stainless 304 pipe. The pipe diameters are 3 in. and 4 in. The header is to be installed in a tank for draining liquids in the process industry. From a quality standpoint, the following safeguards were practiced:

- Tape liner was used to prevent any contact with the carbon steel stands.
- The carbon steel flange was carefully installed to avoid cross-contamination.
- The blue stand is from the stainless pipe spool by using tape on the wheels.
- The horizontal upper arm was sealed to prevent any particulate contamination.
- The pipe spool is purged with an inert gas such as argon or nitrogen to avoid oxygen or moisture infiltration.

A large diameter stainless steel pipe spool is shown in Figure 5. The wheels on the yellow stand are taped to avoid cross-contamination.

Hydro testing on a complex pipe spool is shown in Figure 6. This test is typically carried out using deionised water with a total chloride of less than 70 ppm at 350 psig. Relief values set at 800 psig are installed to prevent rupture and avoid damage. The test is carried out for a minimum of 1 hour to show that there is no loss in pressure, which would indicate a leak. Typically a visual inspection is also carried out and the pipe is carefully inspected to detect any moisture on the outside surface. The customer can be present to observe such a test at the fabrication shop. If this is not possible, a detailed data logger with pictures, charts, and graphs can be provided. Once the pipe has passed the pressure test, it is carefully drained. Residual moisture is blown out with oil-free, moisture-free nitrogen. The ends are capped and sealed for transportation. Flange protectors are used to protect the flanges during transport. Sometimes it is necessary to carry out another hydro test in the field.

Conclusions

Quality needs commitment from senior management to develop the desired culture. An investment in time and people is necessary. Quality and safety go hand-in-hand. Doing it right the first time avoids expensive and time-consuming re-work. A total commitment to quality serves the customer and ultimately provides superior business results.

References

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