8 Disciplines of Problem Solving

Version 1.0

August 2022

CONSTRUCTION INNOVATION HUB

UK Research and Innovation

Contents

List of figures

List of tables

Use of this Guide

The 8 Disciplines of Problem Solving (8D) guideline is part of the Construction Product Quality Planning (CPQP) process and should be used in conjunction with the CPQP Guide and its toolset, published by the Construction Innovation Hub.

Intended as a guideline to aid the process of completing 8D, this document provides the basic principles and a suggested methodology. The templates provided can be changed and modified to suit individual companies.

This guideline is intended for use by companies manufacturing offsite construction products largely using the CPQP process with their customers and suppliers. It aims to provide enough knowledge to enable the CPQP team to complete an 8D process, particularly where this subject is new to them, as well as to provide ongoing aid. Over time, companies will develop their own expertise, methods and standards through training and practice.

For a list of the acronyms and abbreviations used in this document, refer to Appendix C – List of Abbreviations.

For the various terms used in this document, refer to Appendix D – Glossary of Terms.

For further information about the CPQP Guide and its toolset please contact:
cpqp@constructioninnovationhub.org.uk

Introduction

Introduction

The 8 Disciplines of Problem Solving (8D) is a structured problem solving tool. This tool can be widely used within industry and is an essential tool in the Construction Product Quality Planning (CPQP) process. The 8D tool is used for any identified non-conformance issues or any improvements made to products or processes. The tool supports Continual Improvement aspects in the overall quality management.

The 8D problem solving approach covers:

1. Protecting your customer
   Rapidly take action(s) in order to put immediate containment in place to protect the customer;

2. Root Cause Analysis
   Implement Permanent Corrective Action (PCA) on all current products;

3. Identifying and implementing preventative action
   Minimise the future recurrence of the problem, as much as reasonably practicable; and

4. Formation of a management team
   Create commitment to using the 8D process and have practitioners correctly trained to address the problem.

This document explains the procedure for implementing the 8D process within the construction supply chain.

Background

The 8D problem solving methodology was initially developed in the Automotive sector by Ford Motor Company in the 1980s and was previously known as the Team Oriented Problem Solving (TOPS) approach. Early usage of the 8D tool was found to be effective and it was later adopted as the primary method of problem solving, and the approach is still in use today [1]. Today, the methodology has grown to be one of the most popular problem solving approaches used in industries such as automotive and aerospace, but is also successfully applied in healthcare, retail, finance and manufacturing.

Purpose

The main aim behind the use of the 8D problem solving process is to identify the root cause of a problem; implement containment actions to protect customers; and develop and implement corrective actions and preventative measures to prevent future recurrences of similar problems. The tool provides a structured model for problem solving within a product or process by utilising the synergy of a multi-disciplinary team and building transparency at each stage of the 8D process. This problem solving approach not only prevents the recurrence of a particular problem, but also drives systemic change within an organisation or production process, improving the efficiency, quality and cost, while ensuring that the customer's needs are fulfilled.

Benefits

The 8D problem solving methodology has become highly popular as it offers engineering teams a thorough, easy-to-learn structure with clear steps to solving any problem that may arise within a product or production process. Through the application of the tool the following benefits can be expected:

- Improvement in the team's ability to solve problems collaboratively, rather than the reliance on individuals;

- Multi-disciplinary team becomes increasingly familiar with the structure of the problem solving process;
- Database of historical problems and lessons learnt can be documented to prevent future recurrences;
- Improve the effectiveness and efficiency of an organisations ability for problem solving;
- Develop and improve skills for the implementation of corrective actions;
- Implement effective permanent solutions by eliminating the root cause; and
- Improve quality control systems and control plans.

The 8D methodology was developed to highlight the best practices in problem solving, and when performed correctly, the engineering teams are well-prepared for any future problems.

How does 8D fit in with Construction Product Quality Planning?

The Construction Product Quality Planning (CPQP) process supports the development of new products for manufacturing led-construction approaches. The process covers the entire product development cycle, from concept design through to product launch. The CPQP process has been broken down

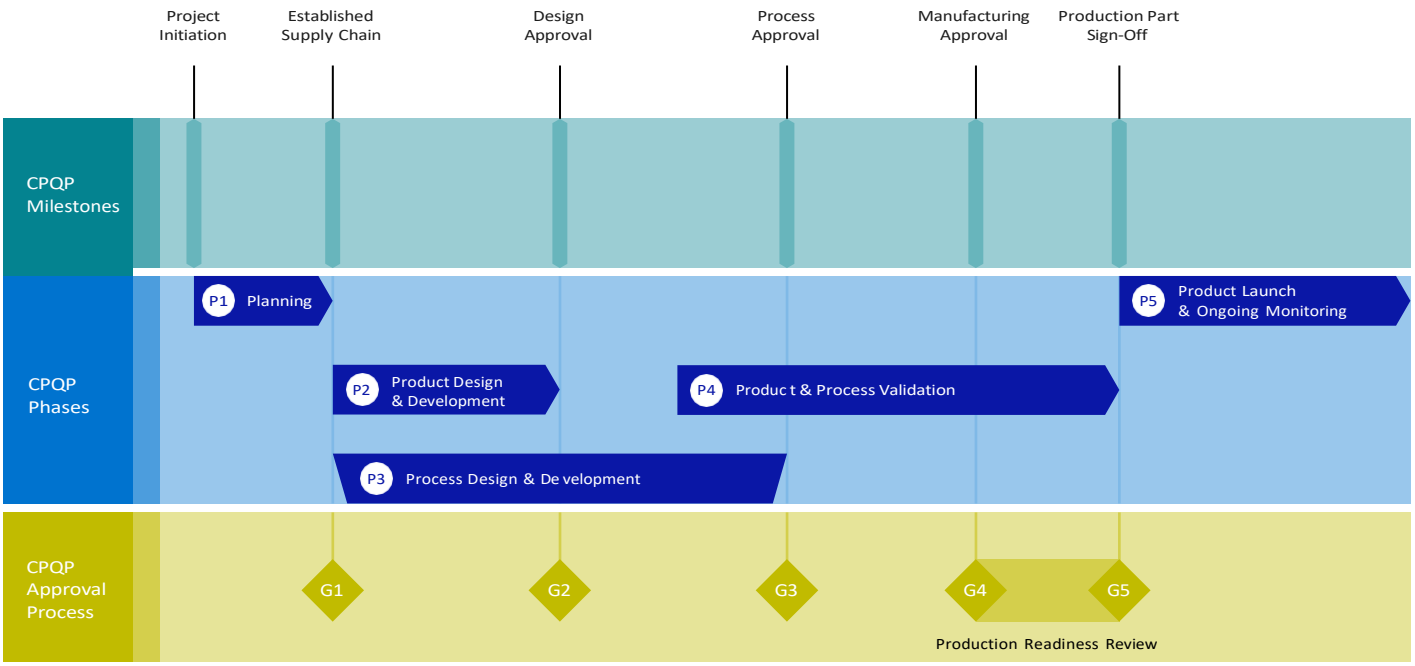


Figure 1. Construction Product Quality Planning (CPQP) Process

into five phases from Planning through to Production Launch & Ongoing Monitoring as shown in Figure 1.

The 8D approach is used when any problem arises during these phases or even during the lifecycle of the product or process. Adoption of this tool helps to identify the root cause and then the implementation of corrective and preventive measures ensures that customers are protected from future recurrences of the problem. The 8D approach fits suitably with the CPQP process as an effective problem-resolution methodology.

Team Approach

The advanced planning approach in the CPQP process is built upon a team-based approach. Similarly, the effective use of the 8D methodology requires the engagement and participation of the cross-functional team. The team composition will vary by organisation and the needs of the product. However, the team should include members from a variety of disciplines with relevant knowledge and experience (i.e. design engineering, process engineering, manufacturing engineering, and quality). It should also include either an external customer representative or an internal party who represents the customer.

Key Definitions

Below are a set of key definitions, which are fundamental in the root cause analysis using the 8D methodology:

- Failure Mode
  The way a component, system, manufacturing or assembly process could potentially fail and become unable to meet or deliver its function(s) or process requirement;
- Generation Point
  Point in the process at which failure mode was created;
- Escape Point
  Earliest point at which detection of the problem should have been observed;
- Problem
  Description of an issue for which a product does not meet the standard requirements;
- Recurrence
  Non-conformance of a product due to the same underlying root cause;
- Interim Containment Action (ICA)
  Taking immediate temporary action(s) to subsequently eliminate or reduce the effect of the Failure Mode on the client until verified Permanent Corrective Actions are put in place;
- Permanent Corrective Action (PCA)
  The long-term action(s) taken in order to fix the problem permanently;
- Root Cause
  Fundamental deficiency or failure of a process. Once resolved, it prevents or significantly reduces the possibility of problem reoccurring; and
- Symptom / Failure Mode Effect
  The measurable effects that are observed when one or more problems are introduced.

Methodology

Methodology

The 8D problem solving process is an effective, thorough and team-orientated approach that can be implemented in the construction industry and supply chain to resolve undeclared non-conformance or quality escapes to customers. Such a situation arises when the customer identifies that the delivered product has issues with its 'fit, form or function'.

The 8D method can be used to quarantine any affected stock, define the problem, identify and verify the root cause(s) of the non-conformance, and put in place corrective actions as well as preventative measures. This ensures that lessons learned through this problem solving process are documented and future recurrences of any such defects are prevented. The 8D process ends by congratulating the team for their involvement.

The key steps of the 8D process are outlined below:

D0	Implement Immediate Containment Action	Define symptom, identify and implement containment action to protect the customer from further exposure to the symptom.
D1	Form the Team	Form a cross-functional team consisting of members from various disciplines with relevant knowledge, experience and skillset to work on the problem.
D2	Define the Problem	Specify the non-conformance by identifying and describing the problem in a quantifiable manner.
D3	Begin Containment Action	Quarantine any contaminated stock that is affecting the customer (ensuring appropriate read across) before the Permanent Corrective Action (PCA) has been implemented.
D4	Root Cause Identification and Verification	Identify and verify the root cause(s), generation and escape point(s). Take permanent action to eliminate future recurrence.
D5	Identifying Corrective Action	Identify PCA(s) that removes the failure mode and ensure it is effective by fixing the process at the escape point(s).
D6	Implementation and Testing of Corrective Action	Plan, implement and check if the corrective action has completely fixed the root cause. Verify the effectiveness of the corrective action through ongoing monitoring.
D7	Planning Preventative Action	Read across to identify other similar products that could be affected by the same root cause and implement the same corrective action if necessary. Document lessons learnt to prevent similar problems.
D8	Recognising the Team	Formally close the project with customer signature and congratulate the team for their involvement in the project.

Table 1. Key steps of 8D problem solving process

Furthermore, a few key requirements shall be considered for the successful outcome of the 8D problem solving method:

- Effective communication
  When the quality escape has been identified, the supplier shall provide full transparency of the 8D process to the customer;

- Correct Training
  Suppliers shall ensure their 8D practitioners are provided with suitable training from providers who can meet the requirements of the training syllabus; and

- Quality Management Systems
  Suppliers shall have their own problem solving process within their own quality management system. This shall meet the requirement standards and, once fully implemented, should be in line with the 8D processes.

Guideline

Guideline

The practitioner carrying out the 8D process shall ensure the completeness of all the steps and actions outlined in this section. In doing so, the check list in Appendix B could also provide additional guidance.

D0 – Implementation of Immediate Containment Action

Once a symptom is observed and there is a potential or identified impact on the customer, the supplier shall carry out immediate containment action(s) in order to protect the customer. Effective containment action requires the practitioner to follow a clear set of tasks as outlined below:

Action		Ensure That	
1	Define the symptom	1	Symptom(s) have been identified and quantified
2	Define immediate containment action(s)	2	Stock is quarantined and isolated (including shipments)
3	Implement selected containment action	3	Stakeholders who are affected have been identified and notified
4	Check if containment action(s) works and provide evidence showing this	4	There is validation of the containment action
5	Check if symptom has been observed before	5	8D form is raised within quality management system

Table 2. Effective containment action task list

D1 – Form the Team

D1 of the 8D process requires a cross-functional team with the participation of engineers, designers, manufacturers, on-site personnel and surveyors that have the relevant knowledge, experience and skillset to work on the problem and successfully conclude the 8D process. It is essential that at least one member of the team is trained to a high standard to implement the 8D problem solving process. This member shall also be accountable for the application of this process. In order to do so, the following actions shall be taken:

1. Identify a Task Team Integrator who shall be responsible for the actions taken, removing barriers and the greater outcome of the application of the 8D methodology.
2. Select the team members.
3. Define the roles and responsibilities of team members.
4. Define the main goal of the problem resolution process.

D2 – Define the Problem

In D2 of the 8D problem solving process, the supplier shall describe the non-conformance by identifying and outlining the problem in a quantifiable manner. Therefore, the following actions shall be taken:

1. Collect and analyse the data, identify the problem, and describe in quantifiable terms. The failure description shall include the following:

- Point of problem discovery;
- Indication of an existing problem described in terms of customer experience;
- Problem impact with respect to quality, productivity and reliability; and
- Problem attention, exploring if it is it possible to narrow the investigation to find the root cause(s) quicker.

2. Record any background information, including but not limited to:

- Specifications and why those specifications were set to that value;
- Previous instances when the same failure occurred and any previous 8D reports that could have been raised; and
- Information that was recorded or missed out from the Process Failure Modes & Effects Analysis (PFMEA).

3. Review the problem with the customer and other affected stakeholders involved. This may be done by using: Is/Is Not analysis, Measles chart, Time maps, Process maps and/or Supplier, Inputs, Process, Outputs and Customers (SIPOC) tools (out of scope for this guideline). This would aid selecting an adequate classification for the failure. Any classification assigned would need to be approved by both the supplier and the client as the classification will determine the priority for the 8D process and report. The higher the classification, the closer the deadline dates are set for each stage of the 8D process. In order to guide the classification decision, the team and client can refer to the PFMEA.

D3 – Begin Containment Action

D3 in the 8D process ensures that the supplier is taking action to isolate the contaminated parts that are affecting the customer. This occurs until the problem can be resolved permanently. Therefore, following actions shall be taken by the supplier:

1. Select and temporarily implement the most effective containment action(s);
2. Collaborate with the customer in determining the locations of the affected product – ensure that the roles and responsibilities, methods and timescale to contain the product are considered and agreed upon;
3. Read across any actions to other part numbers or other products delivered to the customer and then fill in the containment action workbook for the customer to refer to;
4. Verify that the containment action(s) put in place are effective;
5. Maintain clear records of containment for future reference and as per the requirement of the customer; and
6. Once containment action(s) are in effect, notify customers and relevant stakeholders involved about the resumption of shipping.

D4 – Root Cause Identification and Verification

D4 requires identification and verification of the root cause(s) of the problem statement described in stage D2. Therefore, to find the root cause(s), the following actions shall be taken by the supplier:

1. Identify potential cause(s) of the problem and select the ones that describe the problem;
2. Find the generation point(s) and the escape point(s) where the problem should have been detected and contained;
3. Redefine and refine the problem definition if needed;
4. Find root cause(s) for the problem, the escape point and any updates required to the quality management system;
5. Use Fishbone Cause and Effect Diagram, Failure Mode and Effects Analysis (FMEA), TRIZ diagrams, brainstorming maps, N2 diagrams and 5 Whys as tools for identifying the root cause of the problem;
6. Verify escape point(s) and find out the reason they were present; and
7. Verify the root cause(s) found.

In order to help any future reference to the report, any analysis work that was carried out should be attached as an appendix to the report.

D5 – Identifying Corrective Action

Corrective actions are put in place at D5 stage of the 8D process to ensure that the root cause of detected non-conformity (at the escape point) and its recurrence (at generation point) is eliminated. In D5, the following actions shall be considered:

1. Identify Permanent Corrective Action(s) to eliminate the root cause(s) identified in D4;
2. Plan how to implement the corrective action(s);
3. Outline key actions required in order to fix the process at the identified escape point – so further occurrences will not be released but detected instead; and
4. Resource management will also need to be considered such as training and documentation needed to be added or updated.

D6 – Implementation and Testing of Corrective Action

D6 ensures that the supplier implements and tests the corrective action(s). These have been identified to fix root causes in addition to the quality control system at the escape point. The actions outlined below shall be followed:

1. Implement the corrective action in order to fix the root cause;
2. Check that the corrective action has completely fixed the root cause and thus the problem will not reoccur;
3. Ensure complete fix of the quality control system at the generation and escape point(s) from the implementation of the corrective action – hence the problem will be detected and not released;
4. If a non-conforming product is no longer being detected, remove the containment measures;
5. Initiate the removal of containment measures, however, necessary reaction plan(s) need to be put into place in order to avoid recurrence;
6. Update any quality control documentation, such as the PFMEA and control plan, which are required by the customer; and
7. Verify the effectiveness of the chosen corrective action through the ongoing monitoring and include this into the internal auditing system.

D7 – Planning Preventative Action

In D7, systematic action(s) shall be taken by the supplier in order to prevent future recurrence of this problem. A lesson learnt document shall be completed at this stage. In situations where preventative action(s) cannot be put in place, this shall be communicated to the Integrator. The following steps shall be followed:

1. Identify opportunities for similar problems and address them. Identify affected customers and stakeholders involved in such problems;
2. Implement, check and verify all actions to prevent further problems from arising;
3. Prevent similar problems by documenting the lessons learned within a Common Data Environment. This will help to make the problem solving process significantly more efficient;
4. Verify the effectiveness of corrective and preventative action(s); and
5. Read across to other products that could also be affected by the same root cause and implement the same corrective action (if necessary).

D8 – Recognising the Team

Before closure of the project, it is recommended that the supplier shall recognise the efforts and successful outcomes of the team. Thus, the following actions shall be considered:

1. Obtain lessons learnt from the 8D process and document this for future reference;
2. Store problem solving records in a common data environment;
3. Celebrate the achievements of the team with awards and other forms of recognition; and
4. Formally close the project with customer signature.

Worked Example: Defective bathroom pod – 8D application

Worked example

The aim of this worked example is to illustrate the use of the progress tracker template for the 8D problem solving tool.

The example addresses an issue with a defect found in a bathroom pod. The example should not be regarded as a complete and comprehensive case study; it aims only to illustrate the process for conducting an 8D study in a simple manner.

The template of the progress tracker can be found in Appendix A.

8D Report			
Date	14 May 2018	Report Number	8DR0021

Action			Date Due
D0		Immediate Containment	15 May 2018
D1		Form the Team	16 May 2018
D2		Problem Definition	17 May 2018
D3		Containment Action	22 May 2018
D4		Root Cause Analysis	28 May 2018
D5		Permanent Corrective Action	4 June 2018
D6		Validate Corrective Action	4 July 2018
D7		Preventative Action	25 July 2018
D8		Recognise the Team	27 July 2018

Raised By	Anne Green	Position	Project Manager
Company	VGC	Contact	a.green@example.com
Supplier Name	MMC Ltd	Supplier Code	MMCL
Supplier Contact	James Porter	Position	Production Manager
Part No.	IWP40004000200	Part Description	Insulated Wall Panel
Quantity	15	Batch	VG80605

D0		Immediate Containment Action

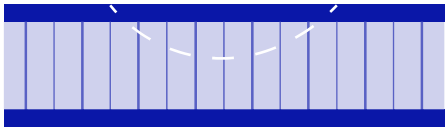
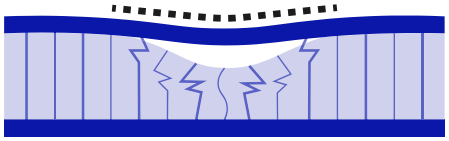
Containment Actions	Date
Production line for IWP40004000200 has been stopped and priority given to other parts needed for VG Construction.	14 May 2018
Queried with transportation company to see if any IWP40004000200 parts are currently in transit and confirmed the response was negative i.e. no additional parts currently in transit.	
Confirmed that there is no other quality escape.	
James Porter has arranged defective parts to be collected from VG Construction site and be delivered to MMC LTD for inspection.	

D1		Form the Team

Position	Name	Contact Number	Email	Signature	Date
Production Manager	James Porter	0208 984 5874	jporter@example.com		15 May 2018
Quality Engineer	Peter Lee	0208 984 5874	plee@example.com		15 May 2018
Design Engineer	Kelly Schwartz	0208 984 5874	kschwartz@example.com		15 May 2018
Team Integrator	Asaf Maura				

D2		Problem Definition

Failure Description	The insulation has debonded from the face sheet on a batch of fifteen insulated wall panels (IWP40004000200) that arrived on the 13th May 2018 which were to be used on 14th May 2018. It could be seen that approximately an average of 50% of the sheets were debonded on each panel. Construction staff reported it to the site project manager, Anne Green, who in turn reported the issue to MMC LTD.
Classification	Significant
Background	Specification for debonding on insulated wall panels is limited to 10mm from edge of panel when delivered. This specification was written into the purchase agreement due to the reason that anything more than 10mm could lead to significant contamination of insulation material during installation and during life cycle.
	PFMEA item 18 states the risk of debonding of face sheet, current corrective actions to deter debonding, is training documents showing the correct way to apply adhesive onto insulation material to ensure little to no debonding occurs.
	8D report 8DR0011 was also raised on debonding of face sheet from insulation material. The root cause at that time was determined to be that training was not adequately provided in how apply the adhesive, especially as it is a water-based adhesive. Therefore, a training document was created, and the application of adhesive was standardised.

Evidence/Images	 Wrinkle  Debonding

D3	Containment Action			
#	Action Taken Against Failure Mode	Responsible Body	Stakeholder(s) Notified? (Y/N)	Date
1	IWP40004000200 resumed production with an additional temporary 100% inspection for all panels coming off the line	Production	Y	22 May 2018
2	Additional packaging was added to transportation to ensure no contamination could reach the panels	Dispatch/ Goods Out	Y	22 May 2018
3	Storage and factory floor checked for out of date adhesives	Production	Y	22 May 2018

D4	Root Cause Analysis				
#	Description of Root Cause	Root Cause Analysis Tool Used?	Has PFMEA Gap Been Identified? (Y/N)	Responsible Bodies Notified? (Y/N)	Date Complete
1	There is no organisational system for the use and retrieval of adhesives from storage	5 Whys	Y	Y	26 May 2018

D5	Permanent Corrective Actions		
#	Permanent Corrective Action(s) Identified	Training Required? (Y/N)	Date Complete
1	Adhesive Register to be created which lists all adhesives stored and used. This will include their expiry dates and whether they are currently in storage or in use. Expired adhesive to be removed from storage and responsibly disposed of.	Y	2 June 2018
2	Storage procedure to be updated to include 'First In, First Out' methodology. The adhesives received first are those that are held longest and therefore closest to obsolescence or expiry, so any adhesives received after, are placed behind the first in order to avoid worthless inventory.	Y	2 June 2018

D6		Validated Corrective Action					
#	Description of PCAs Carried Out	Test Run Complete (Y/N)	Staff/Dept Responsible	Lessons Learnt Training Complete? (Y/N)	Stakeholders Notified? (Y/N)	PFMEA Updated? (Y/N)	Date Complete
1	Register 21-01 Adhesive Register was created and issued as revision 1 on the 29th June. The register was presented to warehouse staff by Peter Lee	Y	Quality Assurance	Y	Y	Y	13 June 2018
2	SOP-08 Warehouse Procedure was updated to include 'First in, first out'	N	Production Department	Y	Y	N	4 July 2018
3	Approval of electronic storage system. Implementation to start immediately	N/A	Production	N/A	Y	N	13 June 2018

D7		Planning Preventative Action					
#	Similar Process or Part	Preventative Action (PA)	Staff/Dept Responsible	Lessons Learnt Training Complete? (Y/N)	Stakeholders Notified? (Y/N)	PFMEA Updated? (Y/N)	Date Complete
1	Storage	Electronic storage system installed using bar code tech. Production staff will have to input job number and then scan barcode. System will alert staff if wrong material/ part is being used or if batch is expired. All storage registers to be retired.	Production	Y	Y	Y	24 July 2018

D8		Recognising the Team			
Supplier Contact	Sign-off Signature	Date	Client Contact	Sign-off Signature	Date
James Porter		27 July 2018	Anne Green		27 July 2018
What Went Well? (Completed by Management)		All deadlines were met Solutions were low cost and efficient			

References and Appendices

References

[1] Automotive Industry Action Group. (2008). Advanced Product Quality Planning (APQP) and Control Plan Reference Manual (2nd ed.). Southfield, MI: Automotive Industry Action Group (AIAG).

[2] British Standards Institution. (2018). Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM): Information management using building information modelling. Part 1: Concepts and principles. BS EN ISO 19650-1. British Standards Institution.

[3] British Standards Institution. (2015). Quality management systems: requirements. BS EN ISO 9001. British Standards Institution.

[4] Tanner, S. & Bailey, M. (2014)., The business improvement handbook. (4th ed.). London, UK: BSI Group.

[5] Russel, J.P. (2003). ISO/TC 176: Continual Improvement Auditing. Retrieved November 2019 from: https://www.qualitywbt.org/FlexTraining/ASP/content/sections/A12/pdfs/01al-vs-ous.pdf.

[6] Aerospace Engine Supplier Quality (AESQ) Committee. (2014). AS 13000: Problem Solving Requirements for Suppliers. SAE International.

Appendices

Appendix A – 8D Problem Solving Template

Templates to be used within the context of this guideline are available, please contact: cpqp@constructioninnovationhub.org.uk

8D Report			
Date		Report Number	

Action			Date Due
D0			
D1			
D2			
D3			
D4			
D5			
D6			
D7			
D8			

Raised By		Position	
Company		Contact	
Supplier Name		Supplier Code	
Supplier Contact		Position	
Part No.		Part Description	
Quantity		Batch	

D0		Immediate Containment Action

Containment Actions	Date

D1		Form the Team

Position	Name	Contact Number	Email	Signature	Date
Team Integrator					

D2		Problem Definition

Failure Description	
Classification	
Background	
Evidence/Images	

D3		Containment Action

#	Action Taken Against Failure Mode	Responsible Body	Stakeholder(s) Notified? (Y/N)	Date

D4		Root Cause Analysis

#	Description of Root Cause	Root Cause Analysis Tool Used?	Has PFMEA Gap Been Identified? (Y/N)	Responsible Bodies Notified? (Y/N)	Date Complete

D5		Permanent Corrective Actions		
#	Permanent Corrective Action(s) Identified		Training Required? (Y/N)	Date Complete

D6		Validated Corrective Action					
#	Description of PCAs Carried Out	Test Run Complete (Y/N)	Staff/Dept Responsible	Lessons Learnt Training Complete? (Y/N)	Stakeholders Notified? (Y/N)	PFMEA Updated? (Y/N)	Date Complete

D7		Planning Preventative Action					
#	Similar Process or Part	Preventative Action (PA)	Staff/Dept Responsible	Lessons Learnt Training Complete? (Y/N)	Stakeholders Notified? (Y/N)	PFMEA Updated? (Y/N)	Date Complete

D8		Recognising the Team			
Supplier Contact	Sign-off Signature	Date	Client Contact	Sign-off Signature	Date
What Went Well? (Completed by Management)					

Appendix B – 8D Check List

	Key Step in 8D	Tasks	Assessing Questions
D0	Implementation of Immediate Containment Action(s)	Emergency Action(s)	• Are emergency actions required? • If so, how were the actions verified and validated?
		8D Application Criteria	• Does the problem fit the application criteria for an 8D process? • Have the effects associated with the problem been quantified? • Have measurements been taken to help quantify the problem? If so, what kind of measurements?
		Key Tasks	1. Review the process flow, FMEA plans, control plan and make changes where necessary. 2. Ensure all the measurable aspects have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D1.
D1	Form the Team	Getting Started	• Has a time and place been confirmed for team meetings? • What sort of team building activities have been organised? • Have key deliverables and goal of the project been clearly defined? • Is the team aware of the customer's viewpoint and their requirements? • Are there any specific skills or courses the team are required to develop to function effectively?
		Roles and Responsibilities	• Has the team goal and individual roles/ responsibilities been clearly defined? • Do all members understand and agree with the final goal? • Has an Integrator with the required decision-making authority been chosen to accomplish its goals?
		Key Tasks	1. Review the process flow, FMEA plans, control plan and make changes where necessary. 2. Ensure all the measurable aspects have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D2.

D2	Defining a Problem	Symptom(s)	• Customers experience with the symptom?
		Problem Description	• Can the specific object and defect be defined? • Do we know with certainty what the problem is? • Has a root cause tool (such as the Is/Is Not analysis) been applied for this specific problem? • Is this a new problem? • When and at which point does this problem first appear? • Are there similar components indicating the same problem? • Has all the data associated with this problem been collected and analysed? Including previous 8D reports • Is there any physical evidence related to the problem?
		Problem Description Review	• Have all the invested client(s) and affected stakeholders been notified? Have they reviewed this? • Is there a need for financial reserves to be set aside? • Have you considered all the social, environmental and legal requirements associated with this problem?
		Key Tasks	1. Review the process flow, FMEA plan, control plan and make changes where necessary. 2. Ensure all the measurable aspects have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D3. 4. Select classification with customer to ensure there is a collective understanding of the timescale required.

D3	Begin Containment Action(s)	Pre-Implementation Considerations	• Are Interim Containment Actions (ICA) required? • Will the clients, stakeholders and field workers involved be entirely protected from the ICA implementation? • How cost effective and time consuming is the implementation of ICA? • Are there any potentially defected products in transit to customers or stores?
		Planning for Implementation	• Have the relevant client, stakeholders and supply chain been involved in making a decision for this planning stage? Do they approve? • Have structured plans, action steps and roles and responsibilities been decided? • Have we identified areas of potential failures during/ after implementation? If so, have preventative measures and contingency action(s) been put into place?
		Post Implementation	• Has the implementation of ICA been validated? If so, does it approve the protection of the customer? • Are the clients and affected stakeholder's content with the ICA? • Can ICA effectiveness be improved for future problems or for similar parts?
		Key Tasks	1. Review the process flow, PFMEA plan, control plan and make changes where necessary. 2. Ensure all the measurable(s) have been reviewed and recorded? 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D4.

D4	Root Cause Identification and Verification	Root Cause Identification	• Has a root cause been identified? • Was the problem description correct or did it require updating? • Which factor(s) in the manufacturing or design process changed/contributed to this problem? • Has the root cause been verified?
		Considerations for Potential Root Cause(s)	• How was the list of potential root cause(s) developed? What were the sources? • Have the toolsets in the CPQP been considered? • Is there more than one potential root cause? • Have all the items on the potential root cause(s) list been verified? Do they match the data collected data in D2?
		Escape Point (within Control System)	• Does a control system exist? If yes, has the current control system been identified? • Has the control system been verified? (i.e. is the control system able to detect the problem?) • Based on the findings, is there a need to improve the current control system?
		Key Tasks	1. Review the process flow, FMEA plan, control plan and make changes where necessary. 2. Ensure all measurable aspects have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D5.

D5	Identifying Corrective Action(s)	Decision making stage	• What was the criteria followed when choosing a Permanent Corrective Action (PCA) for the root cause(s) and escape point(s)? • Which other PCA options have been considered? • What features, benefits and risks would each PCA option offer? And which is the best option?
		Verification Process	• Is there proof verifying this PCA for solving this problem at the root cause level? • Which key variable(s) were measured?
		Post PCA decision	• Do we have the necessary resources required for this PCA implementation in the future on this problem or similar problems? • After implementation of this PCA, what are the chances of it creating further troubles? • Is the containment action(s) in D3 going to be effective until a PCA is implemented? • Are competent teams in place for the planning and implementation of this decision? • Can the containment action(s) in D3 be improved before implementing PCA? • Do the client(s) and stakeholders approve the decision made?
		Key Tasks	1. Review the process flow, FMEA plan, control plan and make changes where necessary. 2. Ensure all the measurable(s) have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D6.

D6	Implementation of Corrective Action(s)	Planning PCA for Implementation	• Which departments are involved in PCA implementation? Have roles and responsibilities been defined? • To what extent are client, stakeholder and supplier inputs required? • Do we have enough resources? If not, has this been communicated with the client? • How is the completion of the PCA plan going to be monitored? • Is the containment action(s) in D3 still required? Or can it be removed? • Have short-term and long-term measurable(s) been defined to validate the outcome of this PCA?
		PCA Validation	• Is the containment action(s) still in effect? • How can the action(s) be proven conclusively? • How will the continuation of long-term results be monitored? • What are the key measurables that will be monitored? • Have the findings been presented to the client(s) and relevant stakeholders? • Has there been an update on all relevant quality documents such as the process control plan, flow charts, and work instructions?
		Key Tasks	1. Review the process flow, FMEA plan, control plan and make changes where necessary. 2. Ensure all the measurable) aspects have been reviewed and recorded. 3. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D7.

D7	Planning Preventative Action	Types of Preventative Action (for this problem and other related problems)	• Did the policies, methods and procedures, and the systems in place allow for this problem to occur and escape? If so, which ones? • How can the root cause(s) and the escape point be prevented from recurring? What were the lessons learnt? • Are there plans written to help standardise practices and aid Preventative Action? • Have the new changes to the practices been presented to client(s), relevant stakeholders and field workers? • Are there any practices, methods and procedures that require standardisation? • Have long-term progress goals been defined for assessing system improvements?
		Future Prevention Recommendations/ Considerations	• What were the management policy, procedures and systems that allowed this problem to occur and escape? • Who has responsibility for leading and monitoring these practices? • Based on lessons learnt from this 8D process, should there be any changes to the business practices?
		Key Tasks	1. Review the process flow, FMEA plan, control plan and make changes where necessary. 2. What lessons have been learnt? 3. Have all the necessary documents,such as the systems, the methods and procedures, been updated? 4. Ensure all measurable aspects have been reviewed and recorded. 5. Ensure the right team of practitioners are in place to validate this step and assist with proceeding to D8.

D8	Recognising the Team	Update to final 8D report	• Have final updates been added to the 8D report? • Has the completed 8D report been shared with the customer and affected stakeholder(s)? • Can the 8D report be found on a common data environment for future reference?
		Recognition	• Have all team members, past and present been listed for their efforts and contributions? • Were any significant individual contributions made that will be rewarded? What were they and how will they be rewarded? • Which method of communication will be used for recognitions? • Were any of the results achieved worthy of sharing with the public?
		Lessons learnt	• Have individual and team lessons learnt been shared, discussed and documented for future reference? • How did the team feel they worked together during the project? • Have the objectives and goals stated at the beginning been met and is the customer now satisfied? • Have suggestions been made regarding the efficiency of the 8D process for future cases? Which steps shall be repeated, and which steps improved? • Finally, how has the completion of the 8D process benefited the company and the overall organisation?

Appendix C – List of Abbreviations

The following is a list of initialisations and acronyms used in this guideline.

0-9	8D	Eight (8) Disciplines of Problem Solving
A	APQP	Advanced Product Quality Planning
C	CPQP	Construction Product Quality Planning
F	FMEA	Failure Mode and Effects Analysis
I	ICA	Interim Containment Action
P	PCA	Permanent Corrective Action
	PFMEA	Process Failure Mode Effects Analysis
S	SIPOC	Supplier Input Process Output Customer
T	TOPS	Team-Oriented Problem Solving

Appendix D – Glossary of Terms

The following is a list of commonly utilised quality, manufacturing and construction specific terms and their definitions within this context used within this guideline.

A Advanced Product Quality Planning (APQP)

A quality framework used for developing new products. It was developed by the automotive industry but can be applied to any industry and is similar in many respects to the concept of design for Six Sigma methodology [1].

C Common Data Environment

'An agreed source of information for any given project or asset, for collecting, managing and disseminating each information container through a managed process.' [2].

Construction Product Quality Planning (CPQP)

An adaptation of Advanced Product Quality Planning (APQP) that is aimed at those enterprises that will feed construction with new componentry for offsite builds.

Continual Improvement

Defined by ISO 9001 as 'To continually improve the suitability, adequacy and effectiveness of the quality management system' [3]. Formerly referred to as 'continuous' improvement within the ISO 9000/9001 lexicon, it was changed to 'continual' in 2000. ISO/Technical Committee 176 decided that 'continuous' implied duration without interruption while 'continual' indicated duration over an extended period, but with intervals of interruption and, therefore, 'continual' was the more appropriate term. [4].

F Failure Mode Effects Analysis (FMEA)

'A tool for facilitating the process of predicting failures, planning preventative measures, estimating the cost of the failure, and planning redundant systems or system responses to failures' [5]. 'The FMEA assists in the identification of CIs as well as key design and process characteristics, helps prioritise action plans for mitigating risk and serves as a repository for lessons learned' [6].

P Process Failure Mode Effects Analysis (PFMEA)

An application of Failure Mode Effects Analysis (FMEA) for process design and implementation.

S Supplier, Inputs, Process, Outputs and Customers (SIPOC)

A tool from Six Sigma that provides a tabular summary of the inputs to outputs of one or more processes, known as a SIPOC diagram. Some organisations refer to it as COPIS in order to put the emphasis on customer requirements.

Disclaimer

This disclaimer governs the use of this publication and by using this publication, you accept the terms of this disclaimer in full. The information contained within this publication does not constitute the provision of technical or legal advice by the Construction Innovation Hub or any of its members and any use made of the information within the publication is at the user's own discretion. This publication is provided 'as is' and neither the Construction Innovation Hub nor any of its members accept liability for any errors within this publication or for any losses arising out of or in connection with the use or misuse of this publication. Nothing in this disclaimer will exclude any liability which cannot be executed or limited by law.

The Construction Innovation Hub is funded by UK Research and Innovation through the Industrial Strategy Challenge Fund

UK Research and Innovation

The Construction Innovation Hub is a consortium between:

mtc Manufacturing Technology Centre

cdbb Centre for Digital Built Britain

bre