

Principles of Quality-by-Design in Pharmaceutical Development

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What is Quality by Design?

The Quality-by-Design (QbD) concept is a systematic approach to development that begins with predefined objectives and emphasizes product and process understanding and process control, based on sound science and [quality risk management](#) [ICH Q8 (R2)].

A key assertion of QbD is that quality is controlled not by simply testing the product, but rather by building quality into the manufacturing process by design. This is achieved by a control strategy that is based on both product and process understanding.

Practical Implementation of QbD Principles

Quality-by-Design implementation is facilitated in Stage 1 (Process Design) of the Process Validation Lifecycle.



Within this workflow, there are multiple risk assessments and deliverables that should be met to develop a robust process and analytical control strategy. They are:

		Deliverables	
Product Understanding	Quality Target Product Profile	QTPP	Define desired quality characteristics of the product.
	Critical Quality Attribute Assessment	CQAs and Ranges	Perform risk assessment to link quality attributes to clinical safety and efficacy.
Process Understanding	ID Process Performance Indicators	PPIs and Ranges	Study the impact of deliberate variations in process parameters and raw materials (inputs) on proposed CQAs and determine process parameter and raw material criticality.
	Pre-Characterization Assessment	Characterization Plan	
	Process Characterization	Characterization Data	
	Process Criticality Assessment	CPPs/ CRMs/ CMAs and Ranges	
Control Strategy	Process Control Strategy	Process Capability Risk	Derived based on understanding and control of sources of variability to ensure product quality and consistency.
	Analytical Control Strategy	Patient Risk Mitigation	

These deliverables and risk assessments:

- form the basis of the design of the product;
- establish critical quality attributes (CQAs) and process performance indicators (PPIs);
- identify process parameters, material attributes, and raw materials with potential impact on CQAs and PPIs; and
- ultimately classify process parameters, material attributes, and raw materials as critical or non-critical.

All together, these items coalesce to create a comprehensive control strategy for the lifecycle of a product. A comprehensive control strategy derived from current product and process understanding assures process performance and consistent, quality production.

Advantages of QbD

1. Continuous Improvement

Continuous improvement is a core focus of QbD. Through this approach, you gain a deeper understanding of your product as it moves through its lifecycle, making it much easier to spot areas of concern.

Once you identify aspects that need improvement, you can adapt your techniques to create a safer product and more efficient manufacturing process. The QbD approach allows for ongoing fine-tuning of your operations, even when [scaling up from the lab to commercial manufacturing](#).

2. Consistency

Using QbD helps companies achieve greater batch-to-batch consistency. Maintaining this type of consistency leads to desirable outcomes not only from regulatory bodies but also from consumers.

Regulators will gain more confidence in you, which may reduce the intensity of their oversight. Consistency also helps companies maintain a high level of [pharma manufacturing operational readiness](#).

From the consumers' end, they will experience fewer or no recalls, resulting in increased trust and credibility.

3. Reduced Controls

The QbD approach builds quality into the manufacturing process by design, reducing the need for controls. Because of this, developers have a good idea of quality even prior to testing. In the end, this can save companies time and money.

4. Failure Prevention

The QbD approach sets manufacturing teams up for success by providing a clear and comprehensive understanding of the parameters involved in the development process and how they work together. This deep understanding helps teams assess risk and act accordingly—significantly reducing the likelihood of failure.

Final Thoughts

A systematic approach like QbD can facilitate continuous improvement and innovation throughout the product lifecycle, maintain consistency of the product, reduce controls, and prevent failure.

While different companies may use different QbD workflows, the underlying concept remains the same and is advantageous to pharmaceutical development.

Let's Work Together

Are you looking to implement a QbD approach? We're ready to help.

[Talk to a QbD Expert](#)