Unit -3
Quality parameter design

1. Introduction

Quality Parameter Design, a cornerstone of robust design, focuses on optimizing product or process design to minimize the impact of uncontrollable variations. Unlike traditional approaches that focus on fixing defects after they occur, Parameter Design aims to create systems that are inherently robust against noise factors, leading to consistent performance and reduced variability. This approach is heavily influenced by the work of Genichi Taguchi, a renowned statistician and engineer.

2. Key Concepts

- **Noise Factors:** These are uncontrollable factors that can influence product or process performance. Examples include environmental conditions (temperature, humidity), material variations, and wear and tear.
- **Control Factors:** These are design parameters that can be adjusted or controlled during the design or manufacturing process to minimize the impact of noise factors. Examples include dimensions, material selection, and process parameters.
- **Signal-to-Noise Ratio (S/N):** Taguchi introduced the concept of S/N ratio to quantify the robustness of a design. It measures the ratio of the desired signal (output) to the noise (variation). A higher S/N ratio indicates a more robust design, less sensitive to noise factors.
- **Orthogonal Arrays:** These experimental designs allow engineers to efficiently investigate the effects of multiple control factors and their interactions with minimal experimentation.

3. The Parameter Design Process

1. **Define the Problem:** Clearly define the quality characteristic to be improved and identify the target value.
2. **Identify Control Factors:** Determine the design parameters that can be adjusted to influence the quality characteristic.
3. **Identify Noise Factors:** Identify the uncontrollable factors that can affect the quality characteristic.
4. **Select Experimental Design:** Choose an appropriate orthogonal array to efficiently test different combinations of control factor levels.
5. **Conduct Experiments:** Conduct experiments using the selected orthogonal array and measure the response variable.
6. **Analyze Data:** Analyze the experimental data using statistical methods to determine the optimal settings of the control factors that minimize the impact of noise factors.
7. **Confirm Results:** Conduct confirmation experiments to validate the optimal settings and assess the robustness of the design.
8. **Implement and Monitor:** Implement the optimized design and continuously monitor the process to ensure ongoing robustness.

4. Benefits of Parameter Design

- **Improved Product Quality:** Reduces variability and improves product consistency.
- **Cost Reduction:** Minimizes the need for rework, scrap, and warranty claims.
- **Increased Customer Satisfaction:** Leads to products that consistently meet customer expectations.
- **Enhanced Competitiveness:** Provides a significant competitive advantage in the marketplace.

5. Example of Parameter Design

[Image of a simple example: A car suspension system.

- **Control Factors:** Spring stiffness, damper damping coefficient.
- **Noise Factors:** Road surface irregularities, vehicle load.
- **Objective:** Minimize the impact of road surface irregularities on ride comfort.]

6. Conclusion

Parameter Design is a powerful tool for improving product and process quality. By proactively addressing the impact of noise factors, engineers can create robust designs that are less sensitive to variations and deliver consistent performance. As technology continues to advance, the application of Parameter Design principles will become increasingly important in various fields, from manufacturing and engineering to healthcare and finance.