GREEN BELT TRAINING

IDEATION TECHNIQUES

Dr.Gopal Sivakumar

Venue: GCT, COIMBATORE

IMPROVE PHASE OVERVIEW

- STEP 10 Generate and evaluate alternative solutions
- STEP 11 Select and optimize best solution
- STEP 12 Pilot, implement and validate the solution

Alternative Solutions generated — 1

2 — Alternative Solutions Evaluated to choose optimum

IMPROVE PHASE DELIVERABLES

Y is re-evaluated to check whether improvement is significant — 4

3 — Piloted & Full scale implementation carried out

Generate and Evaluate Alternative Solutions

Ways to develop alternative solutions

- Brainstorming
- Creative thinking
- Benchmarking

Ways to evaluate alternative solutions

- Risk analysis - FMEA
- Multi-voting
- Nominal group Technique

BRAIN STORMING

- **Round Robin:** Ideas are better generated through brainstorming sessions
- Nothing but a GD session that consist encouraging a voluntary generation of a large volume of creative and new ideas by all the participants
- Participants come from different disciplines
- Later Ideas will be organized for the purpose of finding root cause of a problem

STRUCTURED BRAINSTRMING

- "Round Robin" or "One-at-a-time" are methods of structured brainstorming
- Each person has an equal chance to participate, regardless of rank and personality
- One idea is solicited from each person in sequence

CREATIVE THINKING

- USING PROBING METHODS: Problem solving experts also consider challenging an idea, or disproving an idea to be an initiation point for creative ideas
- Scientists and innovators will like to probe to understand the existence, validity and feasibility of an idea and this helps in improving and optimizing the idea, and may also trigger a new idea

Probing Questions: EXAMPLES

- Why do we have this process step?
- How can we change this step?
- What can be altered?
- Can we combine some tasks?
- Can we apply some learning from other sources?
- Can we maximize impact of certain aspects?

BENCHMARKING

- **BM is the process of measuring products, services, and processes against those of organizations known to be leaders in one or more aspects.**
- Measuring your performance against that of best-in-class companies, determining how the best-in-class achieve those performance levels and using the information as the basis for your own company's targets, strategies and implementation.
- BM research into the best practices at the industry, firm or process level

EXAMPLE

- To achieve improvement in their parts distribution process Xerox Corporation studied the retailer L.L.Bean
- BM look for the best of the best
  - Business awards and citations of merit
    - Best Plant Award (Industry week)
    - Malcom Baldrige Award (Nat. Inst. Of Stds. & Tech.)
    - Quality Cup Award (Rochester Inst. of Tech. & USA Today)
    - Quality Management Award (European Foundation)
    - Deming Prize, Fortune Magazine, Competitiveness Forum

Other Methods of BM

- Academic Research
  - Provides comparison of what separates the best
- Using Exchange Service

After a list of potential candidates, the next step is to choose the best 3 to 5 targets

Multi-voting

- **When to use?**
  - To narrow down a long list of alternatives to a few
- **How to conduct?**
  - Brainstorm to get a list of options
  - Review the list
  - Participants vote for ideas that are worthy
  - Identify items for next round of voting: items having >50% votes
  - Vote again: allow participants to vote only to 50%

Nominal Group Technique

- **When to use?**
  - To gain group consensus, when the issue at hand is controversial
- **How to conduct?**
  - Introduce and explain
  - Generate ideas silently
  - Share ideas
  - Discuss each ideas as a group
  - Voting on ideas: Group members select best 5 ideas and then rank them
  - Decision: Ideas that are most highly rated are the most favored ideas

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DOE & SIMULATION

Dr.Gopal Sivakumar

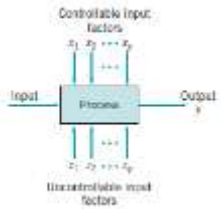
Venue: GCT, COIMBATORE

SELECT & OPTIMIZE BEST SOLUTION

- **Traditional Approach**
  - OFAT
  - Not possible to hold all other variables constant
  - No way to account for joint variation
  - No way to account for experimental error
- **Experiments & Simulation**
  - Interactions can be detected & measured

DESIGN OF EXPERIMENTS

- **A designed experiment** is a series of tests in which purposeful changes are made to the input variables so that we may observe and identify corresponding changes in the output response.
- Some of the process variables x1, x2, . . . , *xp* are **controllable**, whereas others z1, z2, . . . , zq are **uncontrollable**. Sometimes these uncontrollable factors are called **noise** factors.



OBJECTIVES OF DOE

- Determining **which variables are most influential?**
- Determining **where to set the influential x's?**
  - so that *y* is near the nominal requirement.
  - so that variability in *y* is small.
  - so that the effects of the noise are minimized.

SPC & DOE

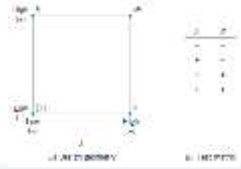
- SPC methods and DoE are two very powerful tools for the improvement and optimization of processes, are closely interrelated
- SPC is a **passive** statistical method, experimental design is an **active** statistical method
- **Application of DoE**
  - Improved yield, Reduced variability and closer conformance to the nominal, Reduced development time, Reduced overall costs

RECOMMENDED PROCEDURE

1. Recognition of and statement of the problem
2. Choice of factors and levels
3. Selection of the response variable
4. Choice of experimental design
5. Performing the experiment
6. Data analysis
7. Conclusions and recommendations

FACTORIAL EXPERIMENTS

- A factorial experiment mean that in each complete trial or replicate of the experiment all possible combinations of the levels of the factors are investigated.
- The simplest type of 2^K design is the 2^2—that is, two factors A and B, each at two levels.



FACTORIAL EXPERIMENTS

- The effects of interest in the 2^2 design are the main effects A and B and the two-factor interaction AB.

MAIN EFFECT OF A

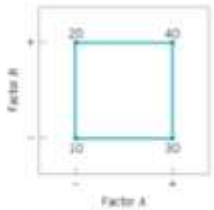
$$A = \nabla_{A^+} - \nabla_{A^-} = \frac{a+ab}{2n} - \frac{b+(1)}{2n} = \frac{1}{2n}[a+ab-b-(1)]$$

MAIN EFFECT OF B

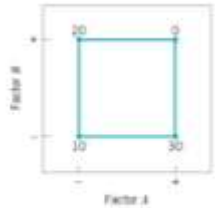
$$B = \nabla_{B^+} - \nabla_{B^-} = \frac{b+ab}{2n} - \frac{a+(1)}{2n} = \frac{1}{2n}[b+ab-a-(1)]$$

INTERACTION EFFECT AB

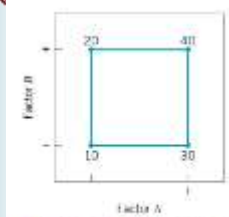
$$AB = \frac{ab+(1)}{2n} - \frac{a+b}{2n} = \frac{1}{2n}[ab+(1)-a-b]$$



■ FIGURE 13.5 A factorial experiment with two factors.



■ FIGURE 13.6 A factorial experiment with interaction.



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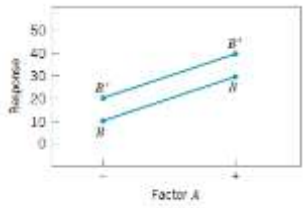
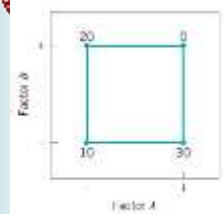
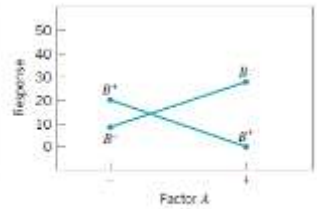


■ FIGURE 13.7 Factorial experiment, no interaction.



■ FIGURE 13.6 A factorial experiment with interaction.



■ FIGURE 13.8 Factorial experiment with interaction.

IMPORTANT TERMS IN DOE

- RESPONSE VARIABLE
- FACTORS
- LEVELS
- BLOCKING
- RANDOMIZING
- REPLICATION

SIMULATION

- Simulation is a means of experimenting with a detailed model of a real system to determine how the system will respond to changes in its structure, environment or underlying assumptions.
- The idea is to create a replica of the real world system that can provide answers to important questions

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PILOT, IMPLEMENT & VALIDATE

Dr.Gopal Sivakumar

Venue: GCT, COIMBATORE

Pilot, Implement & Validate Solution

- Pilot
  - Performed on a small scale
  - Purpose is to make full scale implementation effective
  - Provides expected results, exposes issues and challenges
- Full Scale Implementation
  - Potential Risk Analysis – FMEA
  - Solution Implementation Schedule
  - Training Plan
  - Communication Plan
  - Cost-Benefit Analysis

Improvement Validation

- Revalidate the Measurement System
- Collect data post full scale implementation to evaluate the performance
  - Sigma Level
  - Cp, Cpk
  - Hypothesis tests
  - FMEA

The main deliverable is **Selected Solution.**

Dr.Gopal Sivakumar

campustocorporateprogram@gmail.com