

# ESE 2021

UPSC ENGINEERING SERVICES EXAMINATION

## Preliminary Examination

**General Studies and  
Engineering Aptitude**

**General Principles of Design,  
Drawing and Importance of Safety**

Comprehensive Theory *with* Practice Questions  
*and* ESE Solved Questions





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### **ESE 2021 Preliminary Examination : General Principles of Design, Drawing and Importance of Safety**

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# Preface

The compilation of this book **General Principles of Design, Drawing and Importance of Safety** was motivated by the desire to provide a concise book which can benefit students to understand the concepts of this specific topic of General Studies and Engineering Aptitude section.



**B. Singh** (Ex. IES)

This textbook provides all the requirements of the students, i.e. comprehensive coverage of theory, fundamental concepts and objective type questions articulated in a lucid language. The concise presentation will help the readers grasp the theory of this subject with clarity and apply them with ease to solve objective questions quickly. This book not only covers the syllabus of ESE in a holistic manner but is also useful for many other competitive examinations. All the topics are given the emphasis they deserve so that mere reading of the book clarifies all the concepts.

We have put in our sincere efforts to present detailed theory and MCQs without compromising the accuracy of answers. For the interest of the readers, some notes, do you know and interesting facts are given in the comprehensive manner. At the end of each chapter, sets of practice question are given with their keys, that will allow the readers to evaluate their understanding of the topics and sharpen their question solving skills.

Our team has made their best efforts to remove all possible errors of any kind. Nonetheless, we would highly appreciate and acknowledge if you find and share with us any printing and conceptual errors.

It is impossible to thank all the individuals who helped us, but we would like to sincerely thank all the authors, editors and reviewers for putting in their efforts to publish this book.

With Best Wishes

B. Singh

CMD, MADE EASY

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# 2

# Problem Definition and Information Gathering

## 2.1 INTRODUCTION

This chapter emphasizes the customer satisfaction aspect of problem definition, an approach not always taken in engineering design. This view turns the design problem definition process into the identification of what outcome the customer or end user of the product wants to achieve. Therefore, in product development, the problem definition process is mainly the need identification step. The need identification methods in this chapter draw heavily on processes introduced and proven effective by the total quality management (TQM) movement. TQM emphasizes customer satisfaction.

The chapter ends by proposing an outline of the product design specification (PDS), which serves as the governing documents for the product design. A design team must generate a starting PDS at this point in the design process to guide its design generation. However, the PDS is an evolving document that will not be finalized until the detail design phase of the PDP process.

## 2.2 PRELIMINARY RESEARCH ON CUSTOMER NEEDS

A problem can be regarded as a difference between the actual situation and the desired situation.

This means that in order to identify a problem the team must know where it is meant to be and have a clear understanding of where it currently is in relation to the perceived problem. The Team Purpose, the Team Performance Plan and the Operational Plan can be used to identify where the team should be. If an organized and structured planning process has been followed then the desired position and performance of the team should be clear. However, when a problem arises it is always worthwhile to involve the team members in identifying and understanding the gap between the actual situation and the desired situation. This helps to ensure that all team members understand that a problem exists and that they are an integral part in rectifying the situation.

In this step it is important to clearly describe and document what you and the team consider the problem to be. This helps to ensure that agreement is reached as to the problem and provides a starting point for resolving the problem. Describing the problem also ensures that any confusion about the problem is identified and resolved.

***Gathering Information from Customers:*** It is the customer's desires that ordinarily drive the development of the product, not the engineer's vision of what the customer should want. Information on the customer's needs is obtained through a variety of channels.

***Interviews with customers:*** Active marketing and sales forces should be continuously meeting with current and potential customers. Some corporation have account teams whose responsibility is to visit key customer accounts to probe for problem areas and to cultivate and maintain friendly contact. They report information to current product strengths and weaknesses that will be helpful in product upgrades. An even better approach is for the design team to interview single customers in the service environment where the product will be used.

***Focus groups:*** A focus group is a moderated discussion with 6 to 12 customers or targeted customers of a product. The moderator is a facilitator who use prepared questions to guide the discussion about the



merits and disadvantages of the product. Often the focus group occurs in a room with a one way window that provides for videotaping of the discussion. In both the interviews and the focus groups it is important to record the customer's response in his or her own words. All interpretation is withheld until the analyses of results.

**Customer complaints:** A sure way to learn about needs for product improvement is from customer complaints. These may be recorded by communications (by telephone, letter or email) to a customer information department, service centre or warranty department, or a return centre at a larger retail outlet. Third party Internet websites can be another source of customer input on customer satisfaction with a product. Purchase sites often include customer rating information. Savvy marketing department monitor these sites for information on their products and competing product.

**Warranty data:** Product service centres and warranty departments are a rich and important source of data on the quality of an existing product. Statistics on warranty claims can pinpoint design defects.

**Customer survey:** A written questionnaire is best used for gaining opinions about the redesign of existing products or new products that are well understood by the public. (Innovative new products are better explored with interviews or focus groups.) Other common reasons for conducting a survey are to identify or prioritize problems and to assess whether an implemented solution to a problem was successful. A survey can be done by mail, e-mail, telephone or in person.

## 2.3 CUSTOMER REQUIREMENT

Information gathered from customers and research on products from market literature and experimentation contributes to creating a ranked listing of customer needs and wants. These are the needs that form the end user's opinion about the quality of a product. As odd as it may seem, customers may not express all their requirements of a product when they are interviewed. If a feature has become standard on a product (e.g., a remote control on a TV) it is still a need but no longer excites the end user, and they may forget to mention it. To understand how that can happen and how the omissions can be mitigated, it is necessary to reflect on how customers perceive "needs."

From a global viewpoint, we should recognize that there is a hierarchy of human needs that motivate individuals in general.

- **Physiological needs** such as thirst, hunger, sleep, shelter and exercise. These constitute the basic needs of the body, and until they are satisfied, they remain the prime influence on the individual's behavior.
- **Safety and security needs**, which include protection against danger, deprivation, and threat. When the bodily needs are satisfied, the safety and security needs become dominant.
- **Social needs** for love and esteem by others. These needs include belonging to groups, group identity, and social acceptance.
- **Psychological needs** for self-esteem and self-respect and for accomplishment and recognition.
- **Self-fulfillment needs** for a realization of one's full potential through self-development, creativity and self-expression.

As each need in this hierarchy is satisfied, the emphasis shifts to the next higher need. Our design problem should be related to the basic human needs, some of which may be so obvious that in our modern technological society they are taken for granted. However, within each basic needs there is a hierarchy of problem situation. As the type I problem situations are solved, we move to the solution of higher-level problems within each category of basic need. It is characteristics of our advanced affluent society that, as we move toward the solution of type II and III problem situations, the perception of the need by society as a whole becomes less universal.

### 2.3.1 Differentiating Views of Customer Requirements

From a design team point of view, the customer requirements fit into a broader picture of the PDP requirements, which include product performance, time to market, cost, and quality.

- Performance deals with what the design should do when it is completed and in operation. Design teams do not blindly adopt the customer requirements set determined thus far. However, that set is the foundation used by the design team. Other factors may include requirements by internal customers (e.g., manufacturing) or large retail distributors.
- The time dimension includes all time aspects of the design. Currently, much effort is being given to reducing the PDP cycle time, also known as the time to market, for new products. For many consumer products, the first to market with a great product captures the market.
- Cost pertains to all monetary aspects of the design. It is a paramount consideration of the design team. When all other customer requirements are roughly equal, cost determines most customers' buying decisions. From the design team's point of view, cost is a result of many design decisions and most often be used to make trade-offs among features and deadlines.
- Quality is a complex characteristic with many aspects and definitions. A good definition of quality for the design team is the totality of features and characteristics of a product or service that bear on its ability of satisfy stated or implied needs.

A more inclusive customer requirement than the four listed above is value. Value is the worth of a product or service. It can be expressed by the function provided divided by the cost, or the quality provided divided by the cost. Studies of large, successful companies have shown that the return on investment correlated with high market share and high quality.

According to Joseph Juran, the term quality of a part (or product or component) should refer to the product features that meet customers' needs and satisfaction, and to avoidance from deficiencies that would minimize the chance of failure of the part.

**Table 2.1** Quality Characteristics

Dimensions	Description
Performance	Does the product perform to its standards? Does the product provide the intended service?
Features	What additional benefits may be added to the product? Will there be any tangible or non-tangible benefit?
Reliability	Is the product consistent? Will it perform well over its lifetime and perform consistently?
Durability	How durable is the product? Will it last with daily use?
Conformance	Does your product meet with any agreed internal and national specifications?
Serviceability	Is the product easy to service?
Aesthetics	Is the product appealing to the eye?
Perceived Quality	What sort of quality perception does the marketing team want to convey in the marketing message? Will price charged reflect the quality of the product?

### 2.3.2 Classifying Customer Requirements

Not all customer requirements are equal. This essentially means that customer requirements (or their baseline level of Joseph Juran's dimensions for a quality product) have different values for different people.

The design team must identify those requirements that are most important to the success of the product in its target market and must ensure that those requirements and the needs they meet for the customers are satisfied by the product.

A Kano diagram is a good tool to visually partition customer requirements into categories that will allow for their prioritization. Kano recognized that there are four levels of customer requirements:

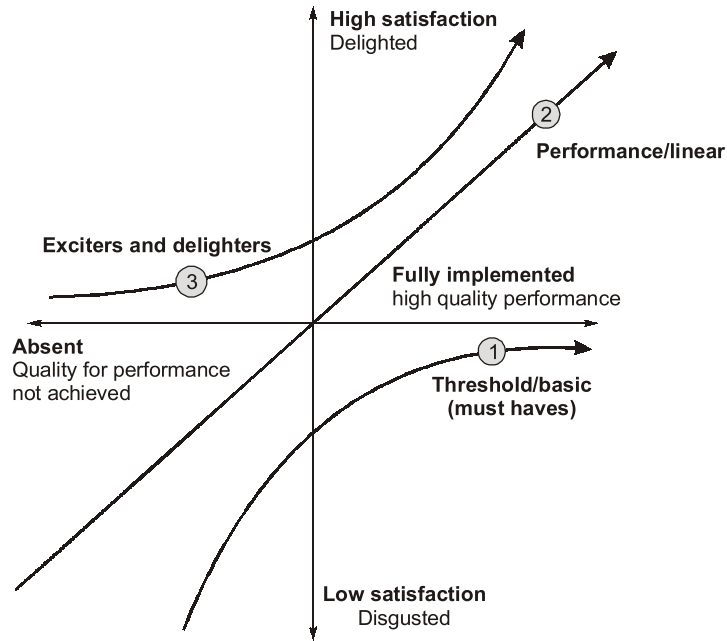


Fig. 2.1 Kano diagram

1. **Expecters:** These are the basic attributes that the one would expect to see in the product, i.e., standard feature. Expecters are frequently easy to measure and are used often in benchmarking.
2. **Spokens:** These are the specific features that customers say they want in the product. Because the customer defines the product in terms of these attributes, the designer must be willing to provide them to satisfy the customer.
3. **Unspokens:** These are product attributes the customer does not generally talk about, but they remain important to him or her. They cannot be ignored. They may be attributes the customer simply forgot to mention or was unwilling to talk about or simply does not realize he or she wants. It takes great skill on the part of the design team to identify the unspoken requirements.
4. **Exciters:** Often called delighters, these are product features, that make the product unique and distinguish it from the competition. Note that the absence of an exciter will not make customers unhappy, since they do not know that is missing.

## 2.4 ESTABLISHING THE ENGINEERING CHARACTERISTICS

Establishing the engineering characteristics is a critical step toward writing the product design specification. The process of identifying the needs that a product must fill is a complicated undertaking. Earlier sections of this chapter focused on gathering and understanding the total picture of what the customer wants from a product. A major challenge of this step is to hear and record the fullness of customer ideas without applying assumptions.

Just knowing what a customer or end user wants from a product is not sufficient for generating designs. The design process only proceeds into concept generation once the product is so well described that it meets with the approval of groups of technical and business discipline specialists and managers. The description fashioned for the approval to start design generation must be a set of all known design



## Objective Brain Teasers

- Q.1** The process of taking something (a device, an electrical component, a software program, etc.) apart and analyzing its working in detail is
- Software engineering
  - Concurrent engineering
  - Sequential engineering
  - Reverse engineering
- Q.2** Which best describes the process of benchmarking?
- Comparison of actual performance with budget
  - Comparison of the costs of one product with another
  - Comparison of direct competitors' performance
  - Comparison of the performance of one operation or business with another
- Q.3** Which of the following statements about benchmarking is not correct?
- Benchmarking can be used by a retailer to set standards.
  - Benchmarking applies only to sales, not operating efficiency.
  - A retailer can benchmark itself against high performance retailers.
  - None of the above
- Q.4** Quality Function Deployment (QFD) is largely focussed on:
- Testing the robustness of a design
  - Reducing costs and preventing unnecessary costs prior to production.
  - To reduce number of parts in a product.
  - Ensuring that the eventual design of a product or service meets customer needs.
- Q.5** The Quality Function Deployment (QFD) is related to
- Technical design parameters.
  - Customer wants and needs.
  - Quality control and needs.
  - Target component characteristics
- Q.6** Body of PDS consists of
- Performance requirements
  - Manufacture requirements
  - Acceptance standards
  - all of these

### Answers

1. (d) 2. (d) 3. (b) 4. (d) 5. (b)  
6. (d)

