UNIT – 2

CONSIDERATIONS OF A GOOD DESIGN

Unit-02/Lecture-01

Objectives of Design Considerations: Design may **strive (struggle)** to include:

- Throughout rate
- Process **yield (Surrender, give up)**
- Product purity

Constraints of Design considerations: In every design attempt, there will be limitations or constraints or some form of **hindrance (obstruction)** some projects may be constrained by **physical space or budget.** Some limited by the choice of materials or colours. And most with a **time constraint**.

To draft your Design Considerations and Constraints, you may begin with asking the following question out loud in our mind:

'To what must I consider?

'To what are some of the constraints? The constraints are....'

- Capital cost
- Available space
- Safety concerns
- Environmental impact and projected effluents and emissions
- Waste production
- Operating and maintenance costs

Other factors that designers may include are:

- Reliability
- **Redundancy (unemployment, dismissal)**
- Flexibility

Consideration of good design:

Design is an adaptable process. To gain a broader understanding of engineering design, we group various considerations of good design into three categories

(1) **achievement of performance requirements**

(2) **life-cycle issues**

(3) **social and regulatory issues**

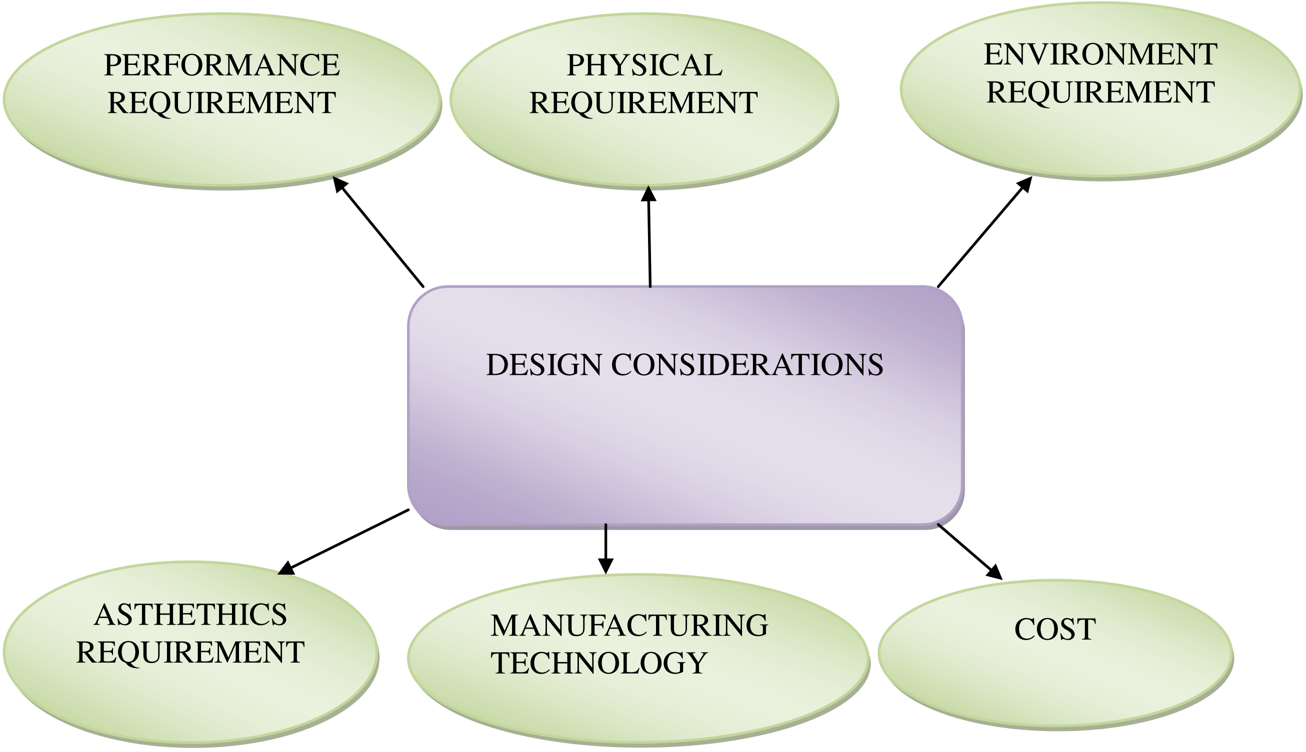
Careful planning of development activities can greatly reduce the time and effort you spend developing a Product. The design considerations phase is where we make a list of factors that need to be considered in broad terms. The type and number of factors we have a unique for each project. That means everyone will have their own set of design considerations specific to their design brief. A good set of design considerations accurately addresses the unique areas of concerns of your proposal as written in your design brief.

The design considerations and constraints will sound like, "**If we want to find what are the areas we must consider and what are the areas of constraints (or limitations)**".
suggest you include a healthy list of

i) Performance requirements :
It is clear that to be realistic the design must demonstrate the required performance.
Performance measures both the function and the behavior of the design, that is, how well the device does what it is designed to do. Performance requirements can be divided into primary performance requirements and complementary performance requirements. A major element of a design is its function. The function of a design is how it is expected to behave.
Example: Consider an ordinary ball bearing. It consists of an outer ring, inner ring, 10 or more balls depending on size, and a retainer to keep the balls from rubbing together. A ball bearing is often called a component, even though it consists of a number of parts. Closely related to the function of a component in a design is its form. Form is what the component looks like, and covers its shape, size, and surface finish. These, in turn, depend upon the material it is made from and the manufacturing processes that are used to make it. A variety of analysis techniques must be employed in arriving at the features of a component in the design. By feature we mean specific physical characteristic, such as the fine details of geometry, dimensions, and tolerances on the dimensions. 9 Typical geometrical features would be fillets, holes, walls, and ribs.
The computer has had a major impact in this area by providing powerful analytical tools based on finite- element analysis. Calculations of stress, temperature, and other field-dependent variables can be made rather handily for complex geometry and loading conditions. When these analytical methods are coupled with interactive computer graphics, we have the exciting capability known as computer-aided engineering (CAE).Note that with this improved capability for analysis comes greater responsibility for providing better understanding of product performance at early stages of the design process.
.

Functional Performance Requirements: They address capacity measures such as forces, strength, energy, material flows, power, deflection, and efficiency of design, its accuracy, sensitivity etc.

Complementary Performance requirements: They are concerned with the useful life of design, its **robustness (toughness, strength)** to factors in the service environment, its reliability, and ease, economy, and safety of maintenance. Issues such as built-in safety features, noise level in operation, all legal requirements, and design codes must be considered



ii) Physical Requirements: These pertain to such issues as size, weight, shape, and surface finish.

iii) Environmental Requirements: There are two separate features. The first concerns the service conditions under which the product must operate. The extremes of temperature, humidity, corrosive conditions, dirt, vibration, noise, etc., must be predicted and allowed for in the design. The second feature of environmental requirements pertains to how the product will behave with regard to maintaining a safe and clean environment, i.e., **green design**. Among these issues is the disposal of the product when it reaches its useful life

iv) Aesthetic Requirements: Aesthetic requirements refer to **“the sense of the beautiful.”** They are concerned with how the product is perceived by a customer because of its shape, color, surface texture, and also such factors as balance, unity, and interest. This aspect of design usually is the responsibility of the industrial designer, as opposed to the engineering designer. The industrial designer is an applied artist. Decisions about the appearance of the product should be an integral part of the initial design concept. An important design consideration is adequate attention to human factors engineering, which uses the sciences of biomechanics, ergonomics, and engineering psychology to assure that the design can be operated efficiently by humans. It applies physiological and anthropometric data to such design features as visual and auditory display of instruments and control systems. It is also concerned with human muscle power and response times. The industrial designer often is responsible for considering the human factors.

v) Manufacturing Technology: This must be **intimately (familiarly)** connected with product design. There may be restrictions on the manufacturing processes that can be used, because of either selection of material or availability of equipment within the company.

vi) Cost: The final major design requirement is cost. Every design has requirements of an economic nature. These include such issues as product development cost, initial product cost, life cycle product cost, tooling cost, and return on investment. In many cases cost is the most important design requirement. If preliminary estimates of product cost look unfavorable, the design project may never be initiated. Cost enters into every aspect of the design process.

Unit-02/Lecture-02

TOTAL LIFE CYCLE

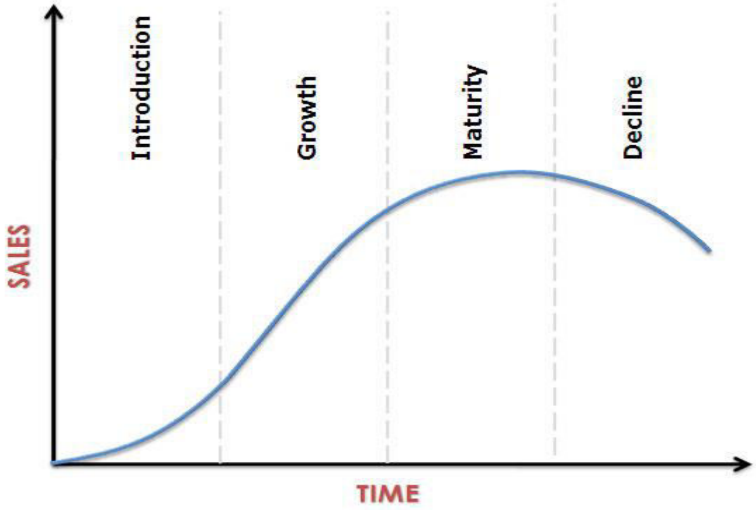
TOTAL LIFE CYCLE:

INTRODUCTION: The total life cycle of a part **starts with the conception of a need** and **ends with the retirement** and disposal of the product. Material selection is a key element in shaping the total life cycle .In selecting materials for a given application; the first step is evaluation of the service conditions. Next, the properties of materials that relate most directly to the service requirements Must be determined. Except in almost **trivial (unimportant, insignificant)** conditions, there is never a simple Relation between service performance and material properties. The design may start with the consideration of static yield strength, but **properties** that are more difficult to evaluate, such as **fatigue, creep, toughness, ductility, and corrosion resistance** may have To be considered. We need to know whether the material is stable under the environmental Conditions. Does the microstructure change with temperature and therefore change The properties? Does the material corrode slowly or wear at an unacceptable rate? Material selection cannot be separated from manufacturability There is a close connection between design and material selection and the manufacturing Processes.

OBJECTIVE: The main objective in this area is a trade-off between the opposing factors Of minimum cost and maximum durability. Durability is the amount of use one Gets from a product before it is no longer useable. Current societal issues of energy conservation, material conservation, and protection of the environment result in new pressures in the selection of materials and manufacturing processes. Energy costs, once nearly ignored in design, are now among the most prominent design considerations. Design for materials recycling also is becoming an important consideration. The life cycle of production and consumption that is characteristic of all products is demonstrate by the materials cycle

Example: This starts with the mining of mineral or the drilling for oil or the harvesting of an agricultural fiber such as cotton. These raw materials must be processed to extract or refine a bulk material (e.g., an aluminum ingot) that is further processed into a finished engineering material (e.g., an aluminum sheet). At this stage an engineer designs a product that is manufactured from the material, and the part is put into service. Eventually the part wears out or becomes obsolete because a better product comes on the market. At this stage, one option is to junk the part and dispose of it in some way that eventually returns the material to the earth. However, society is becoming increasingly concerned with the depletion of natural resources and the haphazard disposal of solid materials. Thus, we look for economical ways to recycle waste materials (e.g., aluminum beverage cans).

A new product progresses through a sequence of stages from introduction to growth, **maturity (development),** and **decline (Turn down).** This sequence is known as the **Total life cycle** and is associated with changes in the marketing situation, thus impacting the marketing strategy.



1) Introduction Stage

The goal of any new product is to meet consumers' needs with a quality product at the lowest possible cost in order to return the highest level of profit. This stage of the cycle could be the most expensive for a company launching a new product. The size of the market for the product is small, which means sales are low, although they will be increasing. On the other hand, the cost of things like research and development, consumer testing, and the MARKETING needed to launch the product can be very high, especially if it’s a competitive sector.

a) **Product:** Branding, Quality level and **intellectual (logical)** property and protections are obtained to **stimulate (motivate)** consumers for the entire product category. Product is under more consideration, as first impression is the last impression.
b) **Pricing:** may be low penetration pricing to build market share rapidly, or high **skim (fly, glide)** pricing to recover development costs.
c) **Distribution:** is selective until consumers show acceptance of the product.
d) **Promotion:** At introductory stage, promotion is done with intention to build brand awareness. Samples/trials are provided that is fruitful in attracting early adopters and potential customers. Promotional programs are more essential in this phase. It is as much important as to produce the product because it positions the product.

2) Growth Stage

The growth stage is typically characterized by a strong growth in sales and profits, and because the company can start to benefit from economies of scale in production, the profit margins, as well as the overall amount of profit, will increase. This makes it possible for businesses to invest more money in the promotional activity to maximize the potential of this growth stage.

a) **Product:** quality is maintained and additional features and support services may be added.
b) **Pricing**: Price is maintained or may increase as company gets high demand at low competition or it may be reduced to grasp more customers
c) **Distribution:** Distribution becomes more significant with the increase demand and acceptability of product. More channels are added for intensive distribution in order to meet increasing demand. On the other hand resellers start getting interested in the product, so trade discounts are also minimum.
d) **Promotion:** At growth stage, promotion is increased. When acceptability of product increases,

more efforts are made for brand preference and loyalty.

3)Maturity Stage

During the maturity stage, the product is established and the aim for the manufacturer is now to maintain the market share they have built up. This is probably the most competitive time for most products and businesses need to invest wisely in any marketing they undertake. They also need to consider any product modifications or improvements to the production process which might give them a competitive advantage.

At maturity, the strong growth in sales reduces. Competition may appear with similar products. The primary objective at this point is to defend market share while maximizing profit.

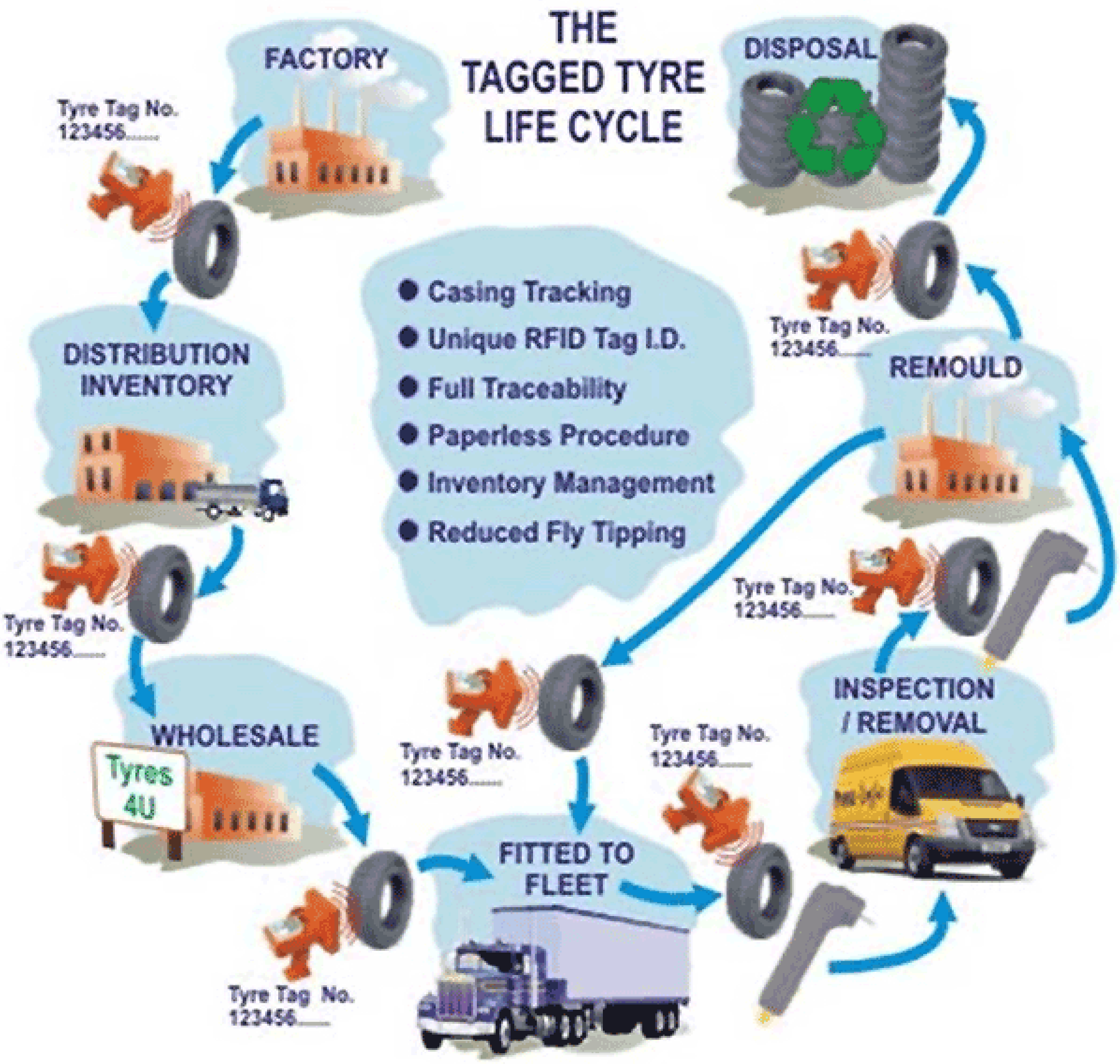
a) **Product:** At maturity stage, companies add features and modify the product in order to compete in MARKET and differentiate the product from competition. At this stage, it is best way to get dominance over competitors and increase market share.
b) **Pricing:** Because of intense competition, at maturity stage, price is reduced in order to compete. It attracts the price **conscious (alert, aware)** segment and **retain (maintain, save)** the customers
c) **Distribution:** becomes more **intensive (serious)** and **incentive (reason)** may be offered to encourage preference over competing products.
d) **Promotion: emphasize (call attention to)** product differentiation.

4) Decline Stage*:* Decline in sales, change in trends and an unfavourable economic condition explain decline stage. At this stage market becomes saturated so sales declines. It may also be due technical obsolescence or customer taste has been changed.

Eventually, the market for a product will start to shrink, and this is what's known as the decline stage. This shrinkage could be due to the market becoming **saturated (i.e. all the customers who will buy the product have already purchased it)**, or because the consumers are switching to a different type of product. While this decline may be **inevitable (Predictable),** it may still be possible for companies to make some profit by switching to less-expensive production methods and cheaper markets Maintain the product; possibly refresh it by adding new features and finding new uses.

a) Harvest the product - reduce costs and continue to offer it, possibly to a loyal function segment.
b) Discontinue the product; settle remaining inventory or selling it to another firm that is willing to continue the product.

For example: The goal of managing a product's life cycle is to maximize its value and profitability at each stage & the product may be changed if it is being re-energized, or left unchanged if it is being harvested or liquidated. The price may be maintained if the product is harvested, or reduced drastically



Limitations of Product Life Cycle :

Product life cycle is disapproved of that it has no experimental support and it is not fruitful in special cases. Different products have different properties so their life cycles also vary. It shows that **product life cycle** is not best tool to predict the sales. Sometimes managerial decisions affect the life of products in this case **Product Life Cycle** is not playing any role. Product life cycle is very fruitful for larger firms and corporations but it is not hundred percent accurate tools to predict the life cycle and sales of products in all the situations

Unit-02/Lecture-03

REGULATORY AND SOCIAL ISSUES IN INDIAN CONTEXT

Regulatory and social issues in Indian context: Regulation refers to **"controlling human or societal behaviour** by rules or regulations or alternatively a rule or order issued by an executive authority or *regulatory* agency of a government and having the force of law". Regulation covers all activities of private or public behaviour that may be **detrimental (harmful)** to societal or governmental interest but its scope varies across countries. It can be operationally defined as "taxes and subsidies of all sorts as well as explicit **legislative and administrative controls** over rates, entry, and other facets of economic activity"Engineering is not only applying scientific laws and principles to technical problems. It is focused on improving the lot of society, and as such, it brings engineers into the mainstream of business and industry.

The following are examples of where a design engineer might be concerned with
legal and **ethical issues**:

- Preparing a contract to secure the services of a product records management firm.
- Reviewing a contract to determine whether a contractor who built an automated Production facility has satisfactorily fulfilled the terms of a contract.
- Deciding whether it is legal and ethical to reverse engineer a product.
- Managing a design project to avoid the possibility of a product **liability (legal responsibility)** suit.
- Protecting the **intellectual (logical, thinker)** property created as part of a new product development Activity.
- Deciding whether to take a job with a direct competitor that is bidding on a contract in the area where you are now working.

The law is a formalized code of conduct describing what society feels is the proper way to behave. In other words, laws reflect what society values. As society evolves, its attitude toward behavior changes, and the laws change as well. Also, the evolution of technology creates new ethical issues

Specifications and standards have an important pressure on design practice. The standards produced by such societies as **ASTM** and **ASME** represent controlled agreement among many elements (users and producers) of industry. As such, they frequently represent minimum standards. When good design requires more than that, it may be necessary to develop your own company or agency standards. On the other hand, because of the general nature of most standards, a standard sometimes requires a producer to meet a requirement that is not essential to the particular function of the design. The codes of ethics of all professional engineering societies require the engineer.To protect public health and safety. Increasingly, legislation has been passed to require federal agencies to regulate many aspects of safety and health. The requirements of the **Occupational Safety and Health Administration (OSHA)**, the **Consumer Product Safety Commission (CPSC)**, the **Environmental Protection Agency (EPA)**, and the **Department of Homeland Security (DHS)** place direct constraints on the designer in the interests of protecting health, safety, and security. Several aspects of the **CPSC** regulations have far-reaching pressure on product design. Although the proposed purpose of a product normally is quite clear, the unplanned uses of that product are not always clear. Under the **CPSC** regulations, the designer has the compulsion to predict as many accidental uses as possible, then develop the design in such a way as to prevent hazardous use of the product in an unintentional but predictable manner. When unplanned use cannot be prevented by functional design, clear, complete, clear-cut warnings must be permanently attached to the product. In addition, the designer must be aware of all advertising material, owner's manuals, and operating instructions that relate to the product to ensure that the contents of the material are reliable with safe operating measures and do not promise performance characteristics that are beyond the capability of the design. An important design consideration is enough attention to human factors engineering, which uses the sciences of biomechanics, ergonomics, and engineering psychology to assure that the design can be operated efficiently and safely by humans. It applies physiological and anthropometric data to such design features as visual and auditory display of instruments and control systems. It is also concerned with human muscle power and response times.

While we have frequently talked about design being a creative process, the fact is that much Of design is not very different from what has been done in the past. There are noticeable benefits in cost and time saved if the best practices are captured and made available for all to use.

Designing with codes and standards has two chief aspects:

(1) it makes the best practice available to everyone, thereby ensuring efficiency and safety, and

(2) It promotes interchangeability and compatibility.

A **code** is a collection of laws and rules that assists a government agency in meeting its compulsion to protect the general welfare by preventing damage to property or injury or loss of life to persons. A **standard** is a generally agreed-upon set of procedures, criteria, dimensions, materials, or parts. Engineering standards may describe the dimensions and sizes of small parts like screws and bearings, the minimum properties of materials, or an agreed-upon procedure to measure a property like fracture toughness. The terms standards and specifications are sometimes used interchangeably. The distinction is that standards refer to generalized situations, while specifications refer to specialized situations. Codes tell the engineer what to do and when and under what circumstances to do it. Codes usually are legal requirements, as in the building code or the fire code. Standards tell the engineer how to do it and are usually regarded as suggestion that do not have the force of law. Codes regularly incorporate national standards into them by reference, and in this way standards become legally enforceable.

There are two broad forms of codes: performance codes and prescriptive codes.

Performance codes: are stated in terms of the specific requirement that is expected to be achieved. The method to achieve the result is not specified.

Prescriptive or specification codes: state the requirements in terms of specific details and leave no diplomacy to the designer. A form of code is government regulations. These are issued by agencies (federal or state) to spell out the details for the implementation of softly written laws.

EXAMPLE: OSHA regulations developed by the U.S. Department of Labor to implement the Occupational Safety and Health Act (OSHA).

Design standards fall into three categories: performance, test methods, and codes of practice. There are published performance standards for many products such as seat belts, lumber, and auto crash safety. Test method standards set forth methods for measuring properties such as yield strength, thermal conductivity, or electrical resistivity. Most of these are developed for and published by **the American Society for Testing and Materials (ASTM).** Another important set of testing standards for products are developed by the **Underwriters Laboratories (UL).** Codes of practice give detailed design methods for repetitive technical problems such as the design of piping, heat exchangers, and pressure vessels. Many of these are developed by **the American Society of Mechanical Engineers (ASME Boiler and Pressure Vessel Code)**, the **American Nuclear Society**, and the **Society of Automotive Engineers**. Standards are often prepared by individual companies for their own proprietary use. They address such things as dimensions, tolerances, forms, manufacturing processes, and finishes. In-house standards are often used by the company purchasing department,when outsourcing. The next level of standard preparation involves groups of companies in the same industry arriving at industry consensus standards. Often these are sponsored through an industry trade association, such as the **American Institute of Steel Construction (AISC)** or the Door and Hardware Institute. Industry standards of this type are usually submitted to the **American National Standards Institute (ANSI)** for a formal review process, approval, and publication. A similar function is played by the **International Organization for Standardization (ISO) in Geneva, Switzerland.** Another important set of standards are government (federal, state, and local) specification standards. Because the government is such a large purchaser of goods and services, it is important for the engineer to have access to these standards. Engineers working in high-tech defense areas must be conversant with MIL standards and handbooks of the Department of Defense.

We start by making a distinction between **morality and professional ethics**.

Morality refers to those standards of conduct that apply to all individuals within society rather Than only to members of a special group. These are the standards that every rational person wants every other person to follow and include standards such as the following:

- Respect the rights of others.
- Show fairness in your dealings with others.
- Be honest in all actions.
- Keep promises and contracts.
- Consider the *welfare* of others.
- Show *compassion* to others.

Note that each of these standards of conduct is based on the italicized values.

Professional ethics: we mean those standards of conduct that every member of a profession expects every other member to follow. These ethical standards apply to members of that group simply because they are members of that professional group. Like morality, standards of ethical conduct are value-based. Some values that are pertinent to professional ethics include:

- Honesty and truth
- Honor —showing respect, integrity, and reputation for achievement
- Knowledge —gained through education and experience
- Efficiency —producing effectively with minimum of unnecessary effort
- **Diligence(carefulness) —persistent(constant)** effort
- Loyalty —**allegiance(commitment, faithfulness)** to employer's goals
- Confidentiality —dependable in safeguarding information
- Protecting public safety and health