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PRATHYUSHA ENGINEERING COLLEGE
DEPARTMENT OF MECHANICAL ENGINEERING
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12	Dr P Jayaraman	Computer integrated Manufacturing Systems

PRATHYUSHA ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

PROFESSIONAL ETHICS

LECTURE NOTES

PREPARED BY

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UNIT I HUMAN VALUES

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

What are human values?

Human values are basic moral values one have to posses to live as a citizen or as a person

The key principles that compose the foundation of Human values are:

1. The inborn dignity of human life
2. Respect and consideration for the other
3. The interconnection between people and the environment and thus the need to take care for and preserve the earth
4. Importance of integrity and service
5. An attitude of non – violence
6. Peace and Happiness

Human values and sub values

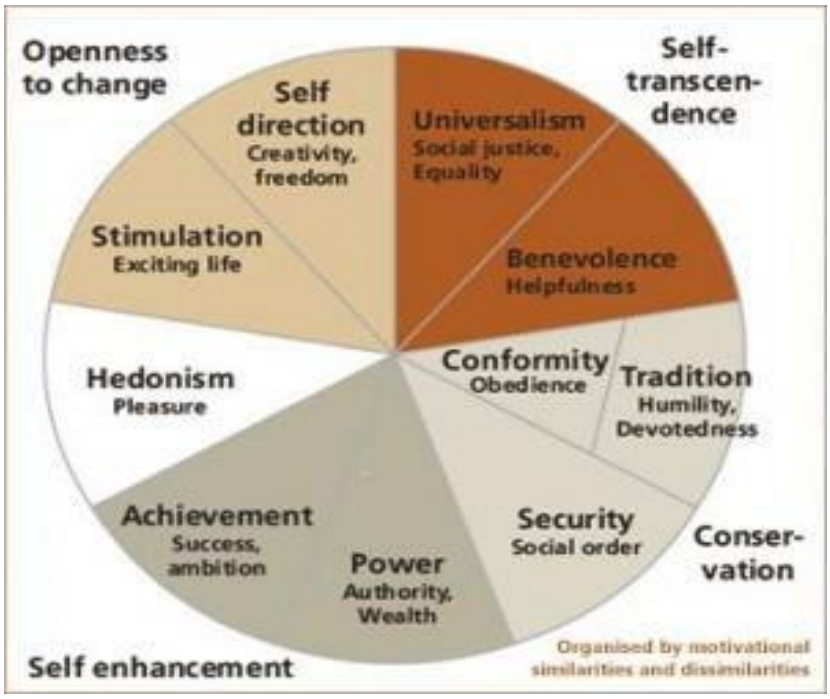
The tree of Human values

The Human have been broadly classified keeping the following values

a. Love : it is the under current that flows through and support the other four values
b. Truth : Love in speech
c. Right conduct : Love in action
d. Peace : Love in thought
e. Non violence : Love in understanding

Theory of Human values

This can be achieved by silence, prayers, storytelling , group singing and group activities



Five Human values and 108 sub values is been framed by Sathya Sai Baba and he want us to follow them to have a pleasant life. IN SathyaSai association April 24th of every year is celebrated has Human value day.

Love	**Truth** **Love in speech**	**Right conduct** Love in action	**Peace** Love in thought	**Non violence** **Love in understanding**
Bliss, caring, compassion, dedication, devotion, empathy, friendship, forgiveness, generosity, helping, human dignity, inner happiness, joy, kindness, patience, purity, sharing, sincerity, sympathy, tolerance, wisdom (21)	Consciousness, creativity, curiosity, discrimination, equality, honesty, integrity, intuition, natural environment, optimism, quest for knowledge, reason, self-analysis, self-knowledge, self-worth, sense control, spirit of inquiry, synthesis, truthfulness, unity in thought word and deed, unity in diversity (21)	Cleanliness, contentment, courage, dependability, duty, ethics, gratitude, goals, good behaviour, healthy living, helpfulness, initiative, leadership, perseverance, time management, resourcefulness, respect, responsibility, sacrifice, self-sufficiency, self-confidence, simplicity (22)	Attention, calm, concentration, contentment, dignity, discipline, endurance, focus, happiness, honesty, humility, inner silence, reflection, satisfaction, self-acceptance, self-confidence, self-control, self-discipline, self-respect, understanding, care for environment, national responsibility (22)	Appreciation of other cultures and religions, brotherhood, ceiling on desires, citizenship, compassion, concern for all life, consideration, co-operation, forgiveness, global awareness, good manners, inclusiveness, loyalty, national awareness, recycling, respect for property, service to other, social justice, sustainable growth, universal love, unwilling to hurt (22)

1 Morals, values and ethics

1.1. Morals:

Definition

a. **Moral refers to the generally accepted standards of right or wrong in a society.**
b. Moral refers to the standards of right conduct and the judgment of particular actions as right or wrong by those standards.
c. Moral theory is a set of moral principals which systematically links moral beliefs to one other.

Characteristic of Moral value

- ✓ Moral value can exist only in free personal being and in that person's voluntary or human acts
- ✓ Moral value in universal in the sense that what one holds for all in the same conditions
- ✓ Moral value in self justifying
- ✓ Moral value has importance over every other value
- ✓ Moral value implies obligation

1.2. **Values**

Definition

Humans have the unique ability to define their identity, choose their values and establish their beliefs. All three of these directly influence a person's behavior. People have gone to great lengths to demonstrate the validity of their beliefs, including war and sacrificing their own life! Conversely, people are not motivated to support or validate the beliefs of another, when those beliefs are contrary to their own. People will act identical with their personal values or what they deem to be important

1. **A value is defined as a principle that promotes well-being or prevents harm.**
2. **Values are our guidelines for our success**
3. Personal values are defined as: **"Emotional beliefs in principles regarded as particularly favorable or important for the individual."** Our values associate emotions to our experiences and guide our choices, decisions and actions.
4. **"Values are the scales we use to weigh our choices for our actions, whether to move towards or away from something."**

Types of Values

The five core human values are: (1) Right conduct, (2) Peace, (3) Truth, (4) Love, and (5) Nonviolence.

1. **Values related to RIGHT CONDUCT are:**
   a) **SELF-HELP SKILLS**: Care of possessions, diet, hygiene, modesty, posture, self reliance, and tidy appearance
   b) **SOCIAL SKILLS:** Good behavior, good manners, good relationships, helpfulness, No wastage, and good environment, and
   c) **ETHICAL SKILLS**: Code of conduct, courage, dependability, duty, efficiency, ingenuity, initiative, perseverance, punctuality, resourcefulness, respect for all, and responsibility
2. **Values related to PEACE are:** Attention, calmness, concentration, contentment, dignity, discipline, equality, equanimity, faithfulness, focus, gratitude, happiness, harmony, humility, inner silence, optimism, patience, reflection, satisfaction, self-acceptance, self-confidence, self-control, self-discipline, self-esteem, self-respect, sense control, tolerance, and understanding

3. **Values related to TRUTH are**: Accuracy, curiosity, discernment, fairness, fearlessness, honesty, integrity (unity of thought, word, and deed), intuition, justice, optimism, purity, quest for knowledge, reason, self-analysis, sincerity, sprit of enquiry, synthesis, trust, truthfulness, and determination.
4. **Values related to LOVE are:** Acceptance, affection, care, compassion, consideration, dedication, devotion, empathy, forbearance, forgiveness, friendship, generosity, gentleness, humanness, interdependence, kindness, patience, patriotism, reverence, sacrifice, selflessness, service, sharing, sympathy, thoughtfulness, tolerance and trust
5. **Values related to NON-VIOLENCE are:**

a) **PSYCHOLOGICAL**: Benevolence, compassion, concern for others, consideration, forbearance, forgiveness, manners, happiness, loyalty, morality, and universal love

b) **SOCIAL:** Appreciation of other cultures and religions, brotherhood, care of environment, citizenship, equality, harmlessness, national awareness, perseverance, respect for property, and social justice.

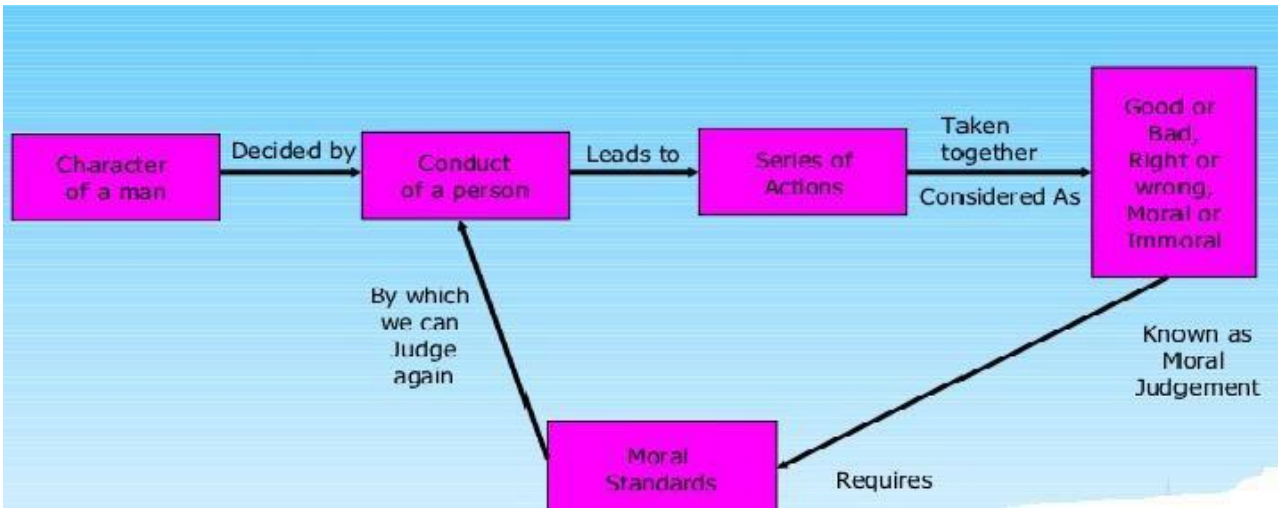
6. **PERSEVERANCE** is defined as persistence, determination, resolution, tenacity, dedication, commitment, constancy, steadfastness, stamina, endurance and indefatigability. To persevere is described as to continue, carry on, stick at it (in formal), keep going, persist, plug away, (informal), remain, stand firm, stand fast, hold on and hang on. Perseverance builds character.
7. **ACCURACY** means freedom from mistake or error; conformity to truth or to a standard or model and exactness. Accuracy is defined as correctness, exactness, authenticity, truth, veracity, closeness to truth (true value) and carefulness. The value of accuracy embraces a large area and has many implications. Engineers are encouraged to demonstrate accuracy in their behavior through the medium of praise and other incentives. Accuracy includes telling the truth, not exaggerating, and taking care over one's work.
8. **DISCERNMENT** means discrimination, perception, penetration, and insight. Discernment means the power to see what is not obvious to the average mind. It stresses accuracy, especially in reading character or motives. Discrimination stresses the power to distinguish or select what is true or genuinely excellent. Perception implies quick and often sympathetic discernment, as of shades of feelings Penetration implies a searching mind that goes beyond what is obvious or superficial. Insight suggests depth of discernment.

Characteristics of Values

- ✓ Values are bipolar, with a positive and negative pole such as pleasant, painful, easy, difficult, strong, weak, rich, poor, beautiful, ugly, true, false, good and bad. The positive pole is the one preferred and the negative pole is disvalue
- ✓ Value are nt homogenous
- ✓ Value should exist
- ✓ Value or worth is a term used for anything that appeals to us in anyway.

1.3. Ethics /ethical – Set of moral principles

- ✓ Ethics is the word that refers to morals, values, and beliefs of the individuals, family or the society. The word derives from the Greek word "ethos", which means **"the characteristic spirit or attitude of a community, people or system"**
- ✓ Ethics is systematic analysis of morality. It is the scientific evolvement and demonstration of morality
- ✓ The study on ethics helps to know the people's beliefs, values, and morals, learn the good and bad of them, and practice them to maximize their well-being and happiness. It involves the inquiry on the existing situations, form judgments and resolve the issues. In addition, ethics tells us how to live, to respond to issues, through the duties, rights, responsibilities, and obligations.
- ✓ **Ethics may be defined as the discipline that deals with what is right or wrong and doing the right thing.**
- ✓ **Meaning of ethics:**



Ethics in relation to other studies:

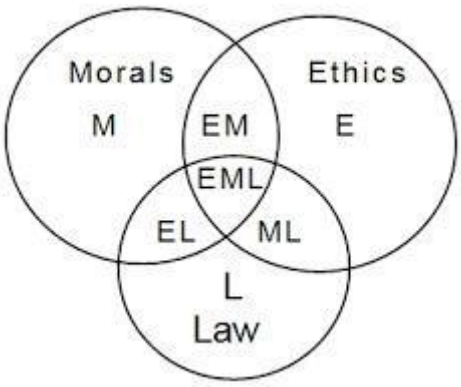
1. **Psychology and ethics:** Both of this deal with human behavior, with the abilities people has and the acts they perform.
2. **Anthropology and ethics:** Both of these deals with human customs on various levels of culture and civilization. This studies the origin and development of human customs without passing any judgment on their moral rightness or wrongness.
3. **Social sciences and ethics:** Social sciences such as social, economic and political science deal with, what they are and how they function and ethics decide it.
4. **Law and ethics:** the study of law is closely related with ethics. It goes with moral law and civil law. The study of civil law deals with the acts what all is permitted and prohibited to us

Ethics can be again classified as:

- **Ethics: A practical science** - this deals with human form to develop inner clarity and to apply intelligence wisely and thoughtfully in the ups and downs of everyday life experience
- **Ethics in a pluralistic society:** societies comprised of many sub groups or sub communities, each of which has its own view of the morality good life. **Here we have to know that a mature persons are free to articulate and choose for themselves the life style, religious benefits, moral convictions and sentiments they want as long as they do no harm to others**

1.4. Law:-

1) Law indicates rules and regulations to be obeyed in the organization.
2) Once the law is implemented in the organization then it is binding to the employees follows it.
3) Laws are rules in written format and governed by authority.



The Importance of Integrity

- Integrity is used to refer to people who act in ways that are consistent with their own code of principles.
- You often reflect on your principles when you consider what you "ought" to do in different situations.

Ethics in the Business World

- Globalization of organizations has created a complex business world.
- Risk is the likelihood of a negative event time's the impact of the event.

Why Business Ethics are Important

- Protect the organization and its employees from legal action.
- Create an organization that operates consistently.
- Produce good business.
- Avoid unfavourable publicity.
- Gain the goodwill of the community.

Code of Conduct

- A guide that highlights an organization's key ethical issues and identifies the overarching values and principles that are important to the organization and that can help in decision making.
- The code of conduct helps ensure that employees:
  - Abide by the law.
  - Follow necessary regulations.
  - Behave in an ethical manner

Ethical Decision Making

1. Get the facts.
2. Identify the stakeholders and their positions.
3. Consider the consequences of your decision.
4. Weigh various guidelines and principles (Virtue, Utilitarian, Fairness, Common Good).
5. Develop and evaluate options.
6. Review your decision.
7. Evaluate the results of your decision.

Four Common Approaches Used in Ethical Decision-Making

Approach to dealing with Moral values	Principle
Virtue ethics approach	The ethical choice best reflects moral virtues in yourself and your community
Utilitarian Approach	The ethical choice produces the greatest excess of benefits over harm.
Fairness approach	The ethical choice treats everyone the same and shows no Favoritism or discriminations
Common good	The ethical choice advances the common good.

Ethics in Information Technology

- The increased use of information technology has raised many ethical issues for today's IT professional.
  - Licensing of IT professionals
  - Internet communication
  - Intellectual property
  - Employee/employer issues

1.5. Integrity

"Integrity is telling myself the truth". – Spencer Johnson

- **Integrity is defined as the unity of thought, word and deed (honesty) and open mindedness**.
- It includes the capacity to communicate the factual information so that others can make well-informed decisions. It yields the person's 'peace of mind', and hence adds strength and consistency in character, decisions, and actions.
- Integrity refers to a quality of a person's character. When it is applied to object, it refers to the wholeness , intactness or purity of a ting
- Integrity paves way to one's success. It is one of the self-direction virtues. It enthuse people not only to execute a job well but to achieve excellence in performance.
- It helps them to own the responsibility and earn self-respect and recognition by doing the job.
- Moral integrity is defined as a virtue (quality), which reflects a consistency of one's attitudes, emotions, and conduct in relation to justified moral values.

Integrity involves in two fundamental intuitions:

- It is primarily a formal relation one has to oneself
- It is connected in an important way to acting morally.
- Integrity is a bridge between responsibility in private and professional life. Integrity makes possible the virtues of self-respect and pride in one's work. It precludes the attitude that one is not personally accountable for one's work. It implies a concern for achieving excellence in the technical aspects of one's work, a strong desire to see the work done well. In turn, this desire constituted a potent stimulus for professional conduct.
- **Integrity is accounted in the following aspects**

(i) **Integrity as self-integration** : Viewing integrity as self-integration is a practice of integrating various parts of their personality into a harmonious use. It is a matter of keeping self intact and without corruption.

(ii) **Integrity as maintenance of identity**: A specific identity has to be maintained in practicising integrity. This action should be according to their commitments not based on certain acceptance of desires.

(iii) **Integrity as standing for something**: Integrity should not be just an act of consistently but should stand for something. As such the social character of integrity is a matter of a person's proper regards for their best judgment

(iv) **Integrity as moral purpose**: Integrity in terms of moral purpose is uses dedication to the pursuit of a rural life.

(v) **Integrity as a virtue**: Integrity is a complex and thick virtue turn. Integrity stands as a mean to various excesses.

Consider this Moral story for integrity

In Africa many years ago, there lived a great King. This king ruled his kingdom with wisdom and might, but he had a problem. There was no child to succeed him when he dies. He had married many wives, but none of them could give him a male child. He thought about it deeply and decided to choose a successor from the kingdom. He told his town crier to make an announcement to all the villagers about his intention requesting that they present just one of their children to come the next day at the village square so he could make his selection.

The next day, the King's palace was filled to the edge with children from different homes in the community. The King handed each of them a particular seed and told them to go home, plant their seeds in a jar and nurse its growth for 8 months. Once the eight months were due, they should return to the palace and he would access how well they've done, then select the best as his heir. There was a young boy from a poor home named Ikeh who received his seed and returned to his village. When he got back, his mom helped him to find a vessel and put some soil into it. Ikeh made sure he watered his pot every day. After each month, the children of the villagers who were given the seed would gather and compare their plants. All the seeds of the other kids have started sprouting and budding, but there was no sign of life in Ikeh's pot despite his efforts. Ikeh was disappointed, but he kept watering his pot daily. A few months passed and now all the other children's pot really came to life. Some had short trees growing in them, some had beautiful flowers and

some had leafy shrubs. Poor Ikeh still had nothing growing in his pot and the other children started to make fun of him. They said he wasn't good enough and couldn't even grow a seed. They jeered at him and called him names. Ikeh was unhappy, but he never for one day failed to water his pot.
Soon, the eight months was over. It was time for the king to choose his heir. Ikeh didn't want to go. He felt there was no need and sat down crying. "I have watered this plant every day." "Why should I go to the palace?" "I have nothing to show for it." Ikeh said to his mother with sadness on his face. His looked at him in the eye and told him to return and show the King his barren vessel, no matter the consequences.
Ikeh reluctantly went to the palace where he met other children dressed in their best and carrying their well grown plants with so much pride. He found more reasons to be sad from what he saw.
The wise King came out of his palace and started to walk through the crowd, looking at the many beautiful trees, shrubs and flowers that were on display by the children. The boys all puffed their chests out and tried to look as royal as possible, hoping that they would be chosen as the successor to the throne.
Then the King came across Ikeh, who was bowing his head in shame. He looked at his pot then he looked at him closely. “What happened?” He asked.
“I watered the pot every day, but nothing ever grew.” Ikeh replied nervously.
Then the King smiled, nodded his head in admiration and moved on. After a few hours of reviewing other children's plants, the Emperor finally completed his assessment.
He stood in front of the children and congratulated them on their efforts.
“Clearly, some of you desperately want to be my heir and would do anything to make that happen, but there is one boy that I would like to point out as he has come to me with nothing. Ikeh, come here please.”
“Oh no,” thought Ikeh. There must be another boy with his name with a grown plant. But the King directed his servants to bring him up. He slowly sauntered to the front of the group, holding his barren pot.
The King held up the vessel for all to see and the other children laughed. Then the King continued, “Eight months ago, I gave you all a seed. I told you to go away, plant the seed and return with your plant. The seeds that I gave you all were burnt up with fire until they were no longer useful and wouldn’t grow, then they were coated to look like good seeds. Now, I see before me thousands of plants and only one barren pot." Therefore, Ikeh is the successor to my throne.

Integrity is vital for success. Most people are ready to do anything to get successful, but few people actually get there. Because those few people value their integrity. The people who are ready to do anything often make serious mistakes which mar their chances of success. The fact that we want to become successful does not mean we should not have value, sound principles, good judgment and character. No!

1.6. Work Ethics

Definition: The work ethic is a cultural norm that advocates being personally accountable and responsible for the work that one does and is based on belief that work has intrinsic value.

- Industry and Society are the two systems which interact with each other and are interdependent. Society requires industry/business system which provides manufacturing, distribution and consumption activities. It needs investment (capital input), labor (input), supply (raw materials), production (industries, business organizations), marketing and distribution (transport), and consumption (public, customer). A lot of transactions (and interactions) between these sub-systems involving people are needed for the welfare of the society. It is here, the work ethics plays an essential role.
- Work ethics is defined as a set of attitudes concerned with the value of work, which forms the motivational orientation.
- The ‘work ethics’ is aimed at ensuring the economy (get job, create wealth, earn salary), productivity (wealth, profit), safety (in workplace), health and hygiene (working conditions), privacy (raise family), security (permanence against contractual, pension, and retirement benefits), cultural and social development (leisure, hobby, and happiness), welfare (social work), environment (anti-pollution activities), and offer opportunities for all, according to their abilities, but without discrimination.
- **Elements of work ethics:**

- Interpersonal skills
- Imitative
- Being dependable

Many complex social problems exist in the industrial/business scenario, because:

- The people desire to be recognized as individuals and treated with dignity, as living human beings. Work is intrinsically valuable so far as it is enjoyable or meaningful in allowing personal expression and self-fulfillment. Meaningful work is worth doing for the sense of personal identity and the self-esteem it holds.
- **Economic independence**: Work is the major instrumental good in life. It is the main source of providing the income needed to avoid economic dependence on others, for obtaining desired materials and services, and for achieving status and recognition from others.
- **Privacy** (personal freedom) of the employee, including women, is to be protected. At the same time, confidentiality of the employer is also to be protected. Mutual trust and loyalty both ways play major roles in this aspect.
- **Security during job and upon retirement**: This concept is being accepted only in government jobs, public limited companies, and corporate organizations. The western thought has influenced the Indian private industries and multinationals in a paradigm shift from 'lifelong employment' to policies such as 'merit only', 'hire and fire', 'pay and use' etc. This situation has no doubt created tension in the Indian scene.
- **Recognition to non-work activities,** such as leisure, paid holiday on the day of visit of a dignitary, social service, and other developmental activities. The workers in prosperous countries are less willing to consider 'work' as their prime interest in life. They claim that such service activities give them peace of mind and happiness. However, such a trend is likely to decline the work ethics.
- **Hard work and productivity** are very essential for the success of an industry. The quality of work life deserves to be improved. Hard labor, undignified jobs (human-drawn rikshaw, people carrying night soil), and hazardous jobs are to be made less straining, dignified, and safer. **Hard work cannot be replaced by 'virtual work".**
- **A different view of work ethics**: Work is considered as a necessary evil. It is a thing one must do in order to avoid worse evils, such as dependency and poverty. That is a major source of anxiety and unhappiness.
- To work (job), is not for monetary considerations only. Human beings believe that it is good to work. Work is good for the body and mind. It promotes self-respect, self-esteem, good for the family, and obligation to the society and allow the world to prosper. Work lays a moral and meaningful foundation for life. That is why, work ethics affirms that, the work per se is worthy, admirable and valuable at personal and social levels. It improves the quality of life and makes life purposeful, successful, and happy.
- By work ethics, duties to the self, family, society, and nation are fulfilled. Rights of the individuals are respected and nourished. Values and virtues are cultivated and enjoyed by all human beings. Further, the quality of life is improved and the environment protected. On the other hand, unemployment and under-employment lead to frustration, social tensions, and occasional militancy. For a developing economy and society, like ours, we need to promote work ethics, at all levels, to flourish as developed nation.

Short story for work ethics:

This is the story of first Indian lady army officer.

Daughter of a policeman was always inspired with the uniform of INDIAN POLICE. She always desired to be there with her father, with uniform.One day in a school function, an army officer was called as Chief Guest. Throughout the function, Man was appraised beyond levels for his bravery and medals he had with him. All girls said" we will marry an army officer". But then came the voice from corner "I will become the army officer".

This was priya jhinghan, who decided to serve Indian army. But it was the time in 1980s, where there was no allocation for women in army. No internet or any family connections with army, but you can't stop the

desire which includes dedicated heart. She went Delhi to contact and wrote a letter to the army admiral of India. After few days, she received a letter with approval to her request but just an unofficial one. There was no official announcement of women recruitment in army.

But she continued to ask the army through various ways, letters and calls were the priorities. Family also helped her but since she completed higher secondary, she moved to get degree from a law college. One day when she was reading newspaper she read the news which gave her goose bumps. It was an announcement calling applicants for women in army. Ahh that was the moment. She filled the form with all her achievements and some answers. On first round 250 were selected. And after interviews, 25 were officially recruited in army. But priya was the first cadet at merit list, admiral himself provided her the way towards army headquarters.

Next was first day of training, but pain in abdomen increased. Priya was admitted to hospital and reported that her kidney has multi stones. The worst throwback to her dreams. Doctors prescribed a full month bed rest, but army rules stated that "if before joining, any officer has long term disorder or he/she suffers 6 days in hospital, then the registration would be cancelled."

Priya knew that, so even with that killing pain, she said "I am absolutely fine and do not have any pain now". Doctors discharged her, but then a hard training was waiting. A 2.5 km run with stones in kidney, who can imagine of that. But her hormones beaten every else reaction of the body and she won the race.

1.7. Service Learning

"It is time that the ideal of success should be replaced by the ideal of service" – Albert Einstein

Service learning is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities.

Service learning may be defined as the non-paid activity, in which service is provided on voluntary basis to the public (have-nots in the community), non-profitable institutions, and charitable organizations. It is the service during learning. This includes training or study on real life problems and their possible solutions, during the formal learning, i.e., courses of study.

Service learning combines service objectives with learning objectives with the intent that the activity changes both the recipient and the provider of the service. This is accomplished by combining service tasks with structured opportunities that link the task to self-reflection, self-discovery, and the acquisition and comprehension of values, skills, and knowledge content.

It is a tool used widely by sociologists to encourage students to make connections between classroom learning and the larger community.

Service learning refers to learning the service policies, procedures, norms, and conditions, other than 'the technical trade practices'. The service learning includes the characteristics of the work, basic requirements, security of the job, and awareness of the procedures, while taking decisions and actions.

Short story for Service Learning

For example, if college students collect trash out of an urban streambed, they are providing a service to the community as Volunteers; a service that is highly valued and important. When the students analyze what they found in the trash bed and possible sources, they can share the results with residents of the neighborhood along with suggestions for reducing pollution. Now we can say that they are engaging in service-learning. In the service-learning, the students are providing an important service to the community and, at the same time, learning about water quality and laboratory analysis, developing an understanding of pollution issues, learning to interpret science issues is to public and practicing communications skills by speaking to residents. *They* may also reflect on their personal and career interests in science, the environment, public policy or other related areas. Thus, service learning combines SERVICE *with* LEARNING in intentional ways**.**

Why Is Service-Learning Important?

Many surveys suggest that effective service-learning programs improve grades, increase attendance in school/College, and develop students' *personal* and social responsibility. A growing body of research recognizes service learning as an effective strategy to *help* students by:

- Promoting learning through active participation in service experiences;
- Providing structured time for students to reflect by thinking, discussing and writing about their service experience;
- Providing an opportunity for students to use skills and knowledge in real-life situations;
- Extending learning beyond the classroom and into the community; and
- Fostering a sense of caring for others.

Service learning also strengthens both education and local communities by:

- Building effective collaborative partnerships between schools or colleges and other institutions and organizations;
- Engaging parents and other adults in .supporting student learning;
- Meeting community needs through the service projects conducted; and
- Providing engaging and productive opportunities for young *people* to work with others in their community.

In the industrial scenario, adoption, study, and development of public health or welfare or safety system of a village or school is an example of service learning by the employees. The engineering student analyzing and executing a socially-relevant project is another example of service learning.

The service learning is a methodology falling under the category of experiential education. It is one of the forms of experiential learning and community service opportunities. It is distinguished in the following ways:

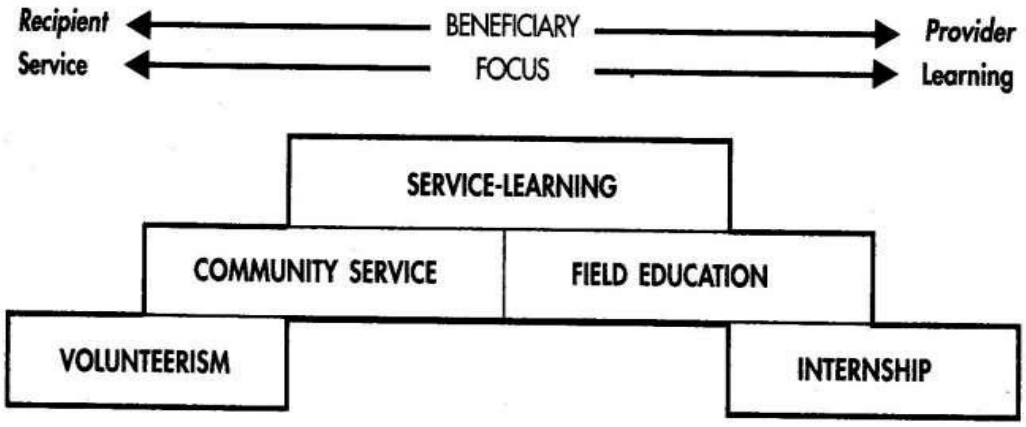
a) **Connection to curriculum:** Integrating the learning into a service project is a key to successful service learning. Academic ties should be clear and built upon existing disciplinary skills.
b) **Learner's voice:** Beyond being actively engaged in the project, trainees have the opportunity to select, design, implement, and evaluate their service activity.
c) **Reflection:** Structured opportunities are created to think, talk, and write about the service experience. The balance of reflection and action allows the trainee to be constantly aware of the impact of their work.
d) **Partners in the community:** Partnership with community agencies are used to identify genuine needs, provide mentorship, and contribute input such as labor and expertise towards completing the project.

Service Learning Vs Volunteerism

Volunteer activities without learning component are equally *important* as service learning, but that the two approaches are fundamentally different activities with different objectives. Both are valued components of a national effort to increase citizen involvement in community service, and at every age.

Characteristics Of Service-Learning

- Service Learning links to academic content and standards.
- It involves young people in helping to determine and meet real, defined community needs.
- It is a reciprocal nature, benefiting both the community and the service provide by combining a experience with a learning experience.
- It can be used in any subject area so long as It is appropriate to learning goal
- It works at all ages, even among young children
- It is positive, m e a n i n g f u l and real to the participants.
- It involves cooperative rather than competitive experiences and thus promo skills associated with teamwork and community involvement and citizenship
- It offers powerful opportunities t o acquire the habits of critical thinking, i.e. ability to identify the most Important questions or issues within a real-world situation.



Differentiating Service-Learning from Other Forms of Education

- **Experiential Learning:** The knowledge and skills acquired through life, work experience and study which have not been formally attested through any educational or professional certification.
- **Internship:** A work-related learning experience for individuals who wish to develop hands on work experience in a certain occupational field
- **Practicum:** A college course that is designed to give students supervised practical application of a previously studied theory

1.8. Civic virtue

"Wisdom is knowing what to do next, virtue is doing it" – David Star Jordan

Definition: Civic virtue is morality or a standard of righteous behaviour in relationship to a citizen's involvement in society.

- An individual may exhibit civic virtue by voting, volunteering and organizing other community activities like group, or attending a public-oriented meeting.
- Civic means, "of, relating to, or belonging to a city, a citizen, or citizenship, municipal or civil society".
- Responsibility refers to "the state or quality of being responsible or something for which one is responsible such as a duty, obligation or burden".
- A citizen is ·a person owing loyalty to and entitled by birth or naturalization to the protection of a state or union".
- Citizenship means "a productive, responsible, caring and contributing member of society
- Civic virtue or civic responsibility is comprised of actions and attitudes associated with democratic governance and social participation.
- Civic responsibility can include participation in government, church, volunteers and memberships of voluntary associations. Actions of civic responsibility can be displayed in advocacy for various causes, such as political, economic, civil, and environmental or quality of life issues.

What are civic virtues

Civic virtues are the moral duties and rights, as a citizen of the village or the country or an integral part of the society and environment. An individual may exhibit civic virtues by voting, volunteering, and organizing welfare groups and meetings.

The duties are:

- To pay taxes to the local government and state, in time.
- To keep the surroundings clean and green.

- Not to pollute the water, land, and air by following hygiene and proper garbage disposal. For example, not to burn wood, tyres, plastic materials, spit in the open, even not to smoke in the open, and not to cause nuisance to the public, are some of the civic (duties) virtues.
- To follow the road safety rules.

On the other hand, the rights are:

- To vote the local or state government.
- To contest in the elections to the local or state government.
- To seek a public welfare facility such as a school, hospital or a community hall or transport or communication facility, for the residents.
- To establish a green and safe environment, pollution free, corruption free, and to follow ethical principles. People are said to have the right to breathe in fresh air, by not allowing smoking in public.
- People have inalienable right to accept or reject a project in their area. One has the right to seek legal remedy, in this respect, through public interest petition.

George Washington embodied the civic virtues as indispensable for a self-governing administration.

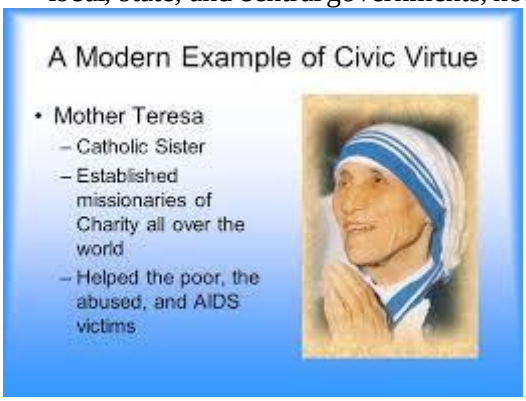
These virtues are divided into four categories:

a) **Civic Knowledge**: Citizens must understand what the Constitution says about how the government is working, and what the government is supposed to do and what not to do. We must understand the basis of our responsibilities as citizens, besides duties and rights. We must be able to recognize when the government or another citizen infringes upon our rights. It implies that the government requires the participation of the enlightened citizens, to serve and survive.

b) **Self-Restraint**: For citizens to live in a free society with limited government each citizen must be able to control or restrain himself; otherwise, we would need a police state—that is, a dictatorial government to maintain safety and order. He advocated for morality and declared that happiness is achieved and sustained through virtues and morals. He advocated and demonstrated self-restraint several times in his private and public life, and naturally he was a great leader.

c) **Self-Assertion**: Self-assertion means that citizens must be proud of their rights, and have the courage to stand up in public and defend their rights. Sometimes, a government may seize the very rights that it was created to protect. In such cases, it is the right of the people to alter or abolish that government (e.g., voting rights, rights call back).

d) **Self-Reliance**: Citizens who cannot provide for themselves will need a large government to take care of them. Once citizens become dependent on government for their basic needs, the people are no longer in a position to demand that government act within the confines of the Constitution. Only a strong self-reliant citizenry will be able to enjoy fully the blessings of liberty. These civic virtues, applicable to local, state, and central governments, nourish freedom and civil liberty at the root of democracy.



1.9. Respect for others

- Respect is a feeling of admiration or deference toward a person, group, ideal, or indeed almost any entity or concept, as well as specific actions and conduct representative of that esteem.
- Respect is of great importance in everyday life. As children we are taught to respect our parents, teachers, and elders, school rules and traffic laws, family and cultural traditions, other

people's feelings and rights, our country's flag and leaders, the truth and people's differing opinions.

- Whether between spouses, friends, co-workers, or business acquaintances, if there is a history of mutual respect and sincere gratitude, the people involved are generally happier and more successful. We live in a world where there are many differences between people, but with an open mind and an appreciation of each person's contributions to this world, we strengthen our relationships and our community.
- We may learn both that our lives together go better when we respect the things that deserve to be respected and that we should respect some things independently of considerations of how our lives would go.

Why Should We Respect Others?

- Having born as a human being and having been a member of the society, he has to be one with the social environment which can be achieved with fellow beings and gives respect to them.
- To be a happy individual, one has to adjust with his friends, relatives, neighbours, and colleagues, etc and give due value to their ideas and actions. In fact being in society itself means a community life which calls for mutual understanding, cooperation and respect.
- Others deserve our respect, our regard, our good thinking about them. It is our moral duty to treat them with respect in order to spread joy and happiness in the family as well as the society. One should live in proportion to ones standing in society. This calls for higher values of friendship, sacrifice. Empathy, sympathy, forgiveness, generosity. Patience. tolerance, equality, integrity and satisfaction.

How to Show Respect

- **Listen** it sounds easy, but listening–truly listening–can be one of the hardest skills to master. If you want a person to know you respect him or her, then tune into what that person is saying. Look them in the eye and offer feedback when necessary. Everyone appreciates the person who willing listens to them and shows genuine interest in what they have to say.
- **Encourage** If you've ever had a bad day, then you know the power a little encouragement can have. We've all had moments when we need someone to tell us, "don't worry, things will work out." It might not seem like much at the time, but that person will remember that you took the time and
- **Congratulate** If someone does a great job, let them know about it. In fact, let everyone know about it. Openly congratulate someone for a job well done, especially if you're a manager. Employees will work harder and happier knowing their manager has a mutual respect for them and is willing to express praise and gratitude when it's deserved.
- **Be Helpful** If you find a friend or co-worker in a jam, be willing to help them if at possible. Not to say you should take on half their project, but offering some advice or throwing in a bit of your time will mean a lot. If that friend or co-worker has helped you in the past, then returning the favour will be a nice way to show both your respect and gratitude.
- **Say Thank** You I'm sure this one seems like common sense, but many people just forget to say thank you or at least forget how to say it with sincerity. A thank you can be as small as two words or as much as buying someone a gift; nevertheless, if the action is not done with 100% sincerity then it is wasted. Make sure people know you appreciate them and their actions. Simply saying

Moral story for Respect Elders

"Respect Your Elders"

"Do not let your parents down, they only brought you up"

Once there was a village named Singapuram. There lived a carpenter named Kasi. He had a younger son who is five years old. His name was Vasu. Kasi's father Ramu was too old and he also stayed with them in their house. Kasi began to think that his father is of no use to him since he became too old and unable to do any work. Kasi always spoke angrily to his father. Ramu was old man and he remained silently whenever Kasi spoke in anger. One day, Kasi gave food in a clay plate for his father to eat. Being too old, Ramu was not able to hold the clay plate properly. He dropped it down and the clay plate broke off. Kasi became so

much angry and scolded his father. Vasu observed this.
The next day, Kasi gave a new clay plate. He went to work. When he came back, he was angry to see the new clay plate also broken into pieces. He scolded his father badly and warned him, "Hey old man, if you break the next clay plate also, there will be no food for you and you have to leave the house". Vasu was listening to his father's words silently. Next day, in the evening, he came back to home after his work. He saw his son Vasu doing some work with his carpentry tools. He became surprised to see this and happily he went near him, Kasi asked Vasu "What are you doing my son?" Vasu replied "Dad, I am making a wood plate for you. When you become old, I will give you this wood plate so that you will not break it and I do not have to send you out of the house"
Kasi realized his mistake on hearing his son's words. He felt sorry for hurting his old aged father. He apologised to his father for his mistakes and his angry words. Kasi, Vasu and his grandfather went into home to have a nice dinner together.

1.10. Living Peaceful

"Unless you can find some sort of loyalty, you cannot find unity and peace in your active living" Josiah Royce

Moral story for Peace

A Legend goes that when God was creating Man he decided to bless him with exceptional talents, skills, gifts in bounty and accessible to almost everything. When it came to peace, he decided to keep it in a place where man could never reach it. There were many suggestions put forth. One thought was to place it high on a mountain, beyond the reach of man. While one was to place it deep below in the ocean where man wouldn't dare to fathom while another was to place it deep in a gorge, where man wouldn't go. God smiled and said there is no such place on earth that man would not look for and reach it. The only place he could find was in a man's mind. This is a place where man will never look and never find it. Most of us would agree with it. Our past and present tells us about mans' adventure, conquests, inventions, research, giant studies in science and technology. But when it comes to living peacefully as neighbors, as society, as neighboring countries… it leaves much to be desired.

- To live peacefully, one should start install peace within (self). Charity begins at home. Then one can spread peace to family, organization where one works, and then to the world, including the environment. Only who are at peace can spread peace.

One should adopt the following means to live peacefully, in the world:

Nurture

1. Order in one's life (self-regulation, discipline, and duty).
2. Pure thoughts in one's soul (loving others, blessing others, friendly, and not criticizing or hurting others by thought, word or deed).
3. Creativity in one's head (useful and constructive).
4. Beauty in one's heart (love, service, happiness, and peace).

Get

5. Good health/body (physical strength for service).

Act

6. Help the needy with head, heart, and hands (charity). Service to the poor is considered holier than the service to God.
7. Not hurting and torturing others either physically, verbally, or mentally.

The following are the factors that promote living, with internal and external peace:

1. Conducive environment (safe, ventilated, illuminated and comfortable).
2. Secured job and motivated with 'recognition and reward'.
3. Absence of threat or tension by pressure due to limitations of money or time.
4. Absence of unnecessary interference or disturbance, except as guidelines.
5. Healthy labor relations and family situations.
6. Service to the needy (physically and mentally-challenged) with love and sympathy.

- Here are the steps which can help you to discover your journey towards living in peace.
  - Seek to love, not control others. ...
  - Find Your Inner Peace. ...
  - Moderate your convictions. ...
  - Be tolerant. ...
  - Be Peace. ...
  - Reflection of thought. ...
  - Seek forgiveness, not revenge. ...
  - Live in joy.
  - Be the change you wish to see in the World.

1.11. Caring

1. **"Caring is knowing, feeling, and acting in the interests of others". - Forcey**
2. **"To care for another person is to help him/her grow and actualize him/herself". - Milton Meyer off.**
3. **"To be concerned about and to facilitate the growth and actualization of other people, the planet, and even oneself". - Harriet Heath.**
4. **Any thoughtful human response (or non-response) that enables others to thrive. - Nel Noddings.**

Moral Story For Caring Is In The Heart

In a ram-shackled house, far from the village, lived a young man who was mentally impaired. He was always seen in the village, working hard to fill his old bag with discarded items and scraps of food. The childre n of the village sneered at him; the elderly villagers looked down on him and scolded their children from coming near him. One day, the villagers learned that the young man had passed away. He had died alone. When they went to his house, they were surprised to find the man's parents, sickly and bed-ridden in the lonely and secluded house. The shock of their discovery brought them to their senses. They quickly realized that the young man whom they had disregarded in their village, despite his mental and physical impairments, was devoted to taking care of his sick and bedridden parents until the day he died. With his death , he taught the villagers a valuable lesson: We can never make assumptions about others, for sometimes the most caring individuals are those we wouldn't suspect.

- Being caring allows you to have empathy for others and to live a life based on affection, love, and compassion for the people around you. Being caring means providing a listening ear, noticing when someone needs help, and helping your community without asking for a reward. If you want to know how to be more caring today, see Steps to get started.
- **To help others to actualize himself**: *To* care *for* another person, in the most significant sense, *is* to *help him grow and actualize himself* ... Caring is the *antithesis* of *simply using the* other person to satisfy one's *own needs",*
- **Caring is an extension of one's self**. "In caring as helping the other grow, I experience what I care for as an extension of myself and at the same time as something separate from me that I respect in its own right. ... For a caring parent, the child is felt to have a worth of his own apart from his power to satisfy the parent's needs. "
- **Devotion and constancy are essential elements of carin:**. "Devotion is essential to caring, just as it is an integral' part of friendship.
- **Caring for another helps the other to care for and about others:** To help another person grow is at least to help him to care for something or someone apart from himself.
- **Help in a way that the cared for can go on to help himself:** Responsive to his own nee care to become responsible for his own life
- **Learning and living a life of caring involves all others:** This disclose the relationship of caring to other concepts like trust, honesty and humility
- **Be polite**: You don't have to be overly formal to be polite. You just have to be considerate of

other people and make them feel comfortable in your presence.

- **Be affectionate:** Actions really can speak louder than words sometimes. Though telling a person you care can make a big difference, sometimes giving that person a hug or putting your arm around him or her can have that extra impact.
- **Listen to people:** When someone is talking to you, make eye contact, put away your phone or other distractions, and don't interrupt them

Caring Steps to get started

- **Be more generous**: Being generous, whether it's with your time or your money, can go a long way in being a more caring person.
- **Treat others like you want to be treated:** If you want to be more caring, then you have to be kind and thoughtful toward others, and think of how you would feel if you were in their shoes.
- **Be considerate of others:** Being considerate is another major aspect of being caring. If you want to be considerate, then you have to respect the people around you, and to avoid making a nuisance of yourself.

1.12. Sharing

"These keys to more abundant living: caring about others, daring for others, sharing with others"

"Happiness is not so much in having as sharing. We make a living by what we get, but we make a life by what we give. Norman Maceven

- Caring influences 'sharing'. Sharing is a process that describes the transfer of knowledge (teaching, learning, and information), experience (training), commodities (material possession) and facilities with others. The transfer should be genuine, legal, positive, voluntary, and without any expectation in return.
- Through this process of sharing, experience, expertise, wisdom and other benefits reach more people faster. Sharing is voluntary and it cannot be driven by force, but motivated successfully through ethical principles. In short, sharing is 'charity'
- For the humanity, 'sharing' is a culture. The 'happiness and wealth' are multiplied and the 'crimes and sufferings' are reduced, by sharing. It paves the way for peace and obviates militancy. Philosophically, the sharing maximizes the happiness for all the human beings. In terms of psychology, the fear, divide, and distrust between the 'haves' and 'have-nots' disappear.
- Sharing not only paves the way to prosperity, early and easily, and sustains it. Economically speaking, benefits are maximized as there is no wastage or loss, and everybody gets one's needs fulfilled and satisfied. Commercially speaking, the profit is maximized.
- Technologically, the productivity and utilization are maximized by sharing.
- In the industrial arena, code-sharing in airlines for bookings on air travels and the common
- Effluent Treatment Plant constructed for small-scale industries in the industrial estates, are some of the examples of sharing. The co-operative societies for producers as well as consumers are typical examples of sharing of the goods, profit and other social benefits.

Moral story for Sharing

The shouting...the screaming…the fighting. That was the breaking point for me as I poured out my woes to my mother. "How can I get them to share as well as we did as kids?", I pleaded. Laughter was her reply. "Well, thanks a lot, mom," I said. "I'm sorry," she chuckled, "but you didn't always share." She went on to explain about the "Box of Misbehaved Toys."

Every time we fought over a toy, she would quietly take that and put it into the box. Yes, I did remember that box. I also remember it wasn't always fair since one person may have caused all the commotion. But my mother was consistent. No matter what the reason for the struggle was, the toy disappeared into the box for one week. No questions asked, and no chance of parole. My siblings and I soon learned that sharing a toy was better than losing it. Often, one person would decide to just wait for a time when no one else was playing with the toy, rather than fight and lose it. It was not a perfect system, but I tried it anyway

That box was a shock to my kids and it was close to full, within a few days…..As the weeks progressed, I noticed the box was emptier and the arguing was less. Today, I heard quiet music to my ears as my son said to his sister, "That's OK, you can play with it."

This story illustrates the worthy joy of sharing as compared to the pain of losing. Sharing is the joint use of a resource or space. In its narrow sense, it refers to joint or alternating use of inherently finite goods, such as a common pasture or a shared residence. It is also the process of dividing and distributing.

Apart from obvious instances, which we can observe in human activity, we can also find many examples of this happening in nature. When an organism takes in nutrition or oxygen for instance, its internal organs are designed to divide and distribute the energy taken in, to supply parts of its body that need it. Flowers divide and distribute their seeds. In a broader sense, it can also include free granting of use rights to goods that can be treated as non rival goods, such as information

1.13. Honesty

"Honesty is the first chapter in the book of wisdom" – Thomas Jefferson

"Honesty is the best policy" is a proverb of Benjamin Franklin;

Honesty means expressing your true feelings. To be emotionally honest we must be emotionally aware which is related to emotionally intelligent. This will also give us the ability to decide when it is in our best interest to be emotionally honest by sharing our feelings. It takes awareness, courage, and self confidence to be emotionally honest.

It is a behaviour showing high moral standards. Honesty has two aspects:

a) **Truthfulness** is to face the responsibilities upon telling truth. One should keep one's word or promise. By admitting one's mistake committed (one needs courage to do that!), it is easy to fix them. Reliable engineering judgment, maintenance of truth, defending the truth, and communicating the truth, only when it does 'good' to others, are some of the reflections of truthfulness.

b) Trustworthiness is maintaining integrity and taking responsibility for personal performance. People abide by law and live by mutual trust. They play the right way to win, according to the laws or rules (legally and morally). They build trust through reliability and authenticity. They admit their own mistakes and confront unethical actions in others and take tough and principled stand, even if unpopular.

Honesty is mirrored in many ways. The common reflections are:

(a) Beliefs (intellectual honesty).
(b) Communication (writing and speech).
(c) Decisions (ideas, discretion).
(d) Actions (means, timing, place, and the goals). and
(e) Intended and unintended results achieved.

a) **Honesty in acts** - It includes not stealing, not engaging in bribes and kickbacks and respecting property of others.
b) **Honesty in speech** - It means not deceiving lying and willingly revealing all pertinent information.
c) **Honesty in beliefs** - It means forming one's beliefs without self-deception or other forms of unpleasant truth.
d) **Honesty in Discretion** - It means involving in the legitimate areas of privacy of the employer or client especially with regard to confidential information.

Honesty is a fundamental virtue for those who engage in the relationships between engineers and then employers and clients.

As against this, some of the actions of an engineer that leads to dishonesty are:

(a) **Lying:** Honesty implies avoidance of lying. An engineer may communicate wrong or distorted test results intentionally or otherwise. It is giving wrong information to the right people
(b) **Deliberate deception:** An engineer may judge or decide on matters one is not familiar or with insufficient data or proof, to impress upon the customers or employers. This is a self deceit.
(c) **Withholding the information:** It means hiding the facts during communication to one's superior or subordinate, intentionally or otherwise.
(d) **Not seeking the truth:** Some engineers accept the information or data, without applying their mind and seeking the truth.

(e) **Not maintaining confidentiality:** It is giving right information to wrong people. The engineers should keep information of their customers/clients or of their employers confidential and should not discuss them with others.

(f) **Giving professional judgment** under the influence of extraneous factors such as personal benefits and prejudice. The laws, experience, social welfare, and even conscience are given a go-bye by such actions. Certainly this is a higher-order crime.

1.14. Courage

1. **"Courage is the first of human qualities because it is the quality which guarantees all others?" – Winston Churchill**
2. **"Courage means the ability to face down those imaginary fears in reclaim the far more powerful life that we have denied ourselves"**
3. **"Courage is not the absence of fear, but rather the judgment that something else IS more important than fear." - Ambrose edmoon.**
4. **"Courage is resistance to fear, mastery of fear - not absence of fear." – Mark Twain**

- The word courage derives from the Latin **cor,** which means **"heart".** But true courage is more a matter of mental power than of feeling.
- Courage (also called bravery, bravado or valour) is the choice and willingness to confront agony, pain, danger, uncertainty or intimidation. Physical courage is courage in the face of physical pain, hardship, death or threat of death, while moral courage is the ability to act rightly in the face of popular opposition, shame, scandal, discouragement, or personal loss.
- Courage is the tendency to accept and face risks and difficult tasks in rational ways. Self-confidence is the basic requirement to nurture courage.
- **Courage is classified into three types, based on the types of risks, namely**

a) **Physical courage:** In physical courage, the thrust is on the adequacy of the physical strength, including the muscle power and armaments. People with high adrenalin, may be prepared to face challenges for the mere 'thrill' or driven by a decision to 'excel'.,

b) **Social courage:** The social courage involves the decisions and actions to change the order, based on the conviction for or against certain social behaviors. This requires leadership abilities, including empathy and sacrifice, to mobilize and motivate the followers, for the social cause.

c) **Intellectual courage:** The intellectual courage is inculcated in people through acquired knowledge, experience, games, tactics, education, and training. In professional ethics, courage is applicable to the employers, employees, public, and the press.

- One should perform Strengths, Weakness, Opportunities, and Threat (SWOT) analysis. Calculate (estimate) the risks, compare with one's strengths, and anticipate the end results, while taking decisions and before getting into action.

Incident to witness courage:

Facing the criticism, owning responsibility, and accepting the mistakes or errors when committed and exposed are the expressions of courage. In fact, this sets their mind to be vigilant against the past mistakes, and creative in finding the alternate means to achieve the desired objectives. Prof. Sathish Dhawan, Chief of ISRO, was reported to have exhibited his courage and owned responsibility, when the previous space mission failed, but credited Prof. A.P.J. Abdul Kalam (now our revered President), when the subsequent mission succeeded.

Characteristics of owned by courageous people

a) Perseverance (sustained hard work),
b) Experimentation (preparedness to face the challenges, that is, unexpected or unintended results),
c) Involvement (attitude, clear and firm resolve to act), and
d) Commitment (willing to get into action and to reach the desired goals by any alternative but ethical means).

1.15. Valuing Time

- **"Time is measure of one's usefulness and success"**
- **"Life is best enjoyed when time periods are evenly divided between labor, sleep and recreation. All people should speed one-third of their time in recreation which is rebuilding, voluntary activity, never idleness" – Brigham young**
- **"Time is money"**

- A first step in good time management is to understand the value of your time. Hard working people have no time for rest and recreation. **Time management is the rational way to ensure that our limited time is always used effectively**
- If you are employed by someone else, you need to understand how much your employer is paying for your time, and how much profit he or she expects to make from you.
- If you are working for yourself, you should have an idea of how much income you want to bring in after tax. By working these figures back to an hourly rate, this gives you an idea of the value of your time.
- By knowing the value of your time, we have to take it as a resource. It is unique, which cannot be accumulated and stored like money. . we have to use it effectively and efficiently.
- Time is rare resource. Once it is spent, it is lost forever. It cannot be either stored or recovered. Hence, time is the most perishable and most valuable resource too. This resource is continuously spent, whether any decision or action is taken or not.
- We can identify the wasters of time by following ways:
    - Unscheduled and schedule meetings
    - Lack of adequate planning
    - Poor delegation
    - Too much socializing
    - Ineffective communication
    - Unnecessary public responsibilities
    - Lack of goals and objectives
    - Poor supervision
    - Poor use of telephone

Time management principles:

- Clear objective
- Prioritize task
- Greatly increase your productivity and effectiveness
- Feel less stress and worry
- Control your schedule and the way you spend your time
- Achieve more with less time
- Have more time for fun and the things and people you love
- The history of great reformers and innovators have stressed the importance of time and valuing time. The proverbs,
  'Time and tide wait for nobody' and
  'Procrastination is the thief of time' amply illustrate this point.

Moral story for Valuing Time:

An story to highlight the 'value of time' is as follows: To realize the value of one year, ask the student who has failed in the examinations;. To realize the value of one month, ask the mother who has delivered a premature baby; to realize the value of one week, ask the editor of weekly; to realize the value of one day, ask the daily-wage laborer; to realize now the value of one hour, ask the lovers longing to meet; to realize the value of one minute, ask a person who has missed the train; to realize the value of one second, ask the person who has survived an accident; to realize the value one millisecond, ask the person who has won the bronze medal in Olympics; to realize the value of one micro second, ask the NASA team of scientists; to realize the value of one nanosecond, ask a Hardware engineer

1.16. Cooperation

Teamwork requires cooperation of all the members of the team. The sayings are: "Pulling together can move mountains"; "Unity gives strength"; "United we stand, divided we fall "; "A bundle of sticks cannot be broken as it is, but individual sticks can be broken easily'. Thus cooperation in any work adds strength and leads to success.

- Cooperation is the process of groups of organisms working or acting together for common or mutual benefit, as opposed to working in competition for selfish benefit.
- Man is a social animal. He lives in a society on which he is largely dependent and to which his contribution matters. Man cannot make his living all by himself. He has to depend on others for many things. Usually many works have to be done by several persons collectively. Construction of a building, running an institution, organizing a community function or a meeting requires the work and help of many individuals.
- Man must learn to cooperate with others. It gives not only strengths and success in completing a work, but also a peace of mind and happiness in contributing the pleasures of that collective effort and success. Without cooperation there would be disorder, confusion, inadequacy, and fear of failure.
- There are departments of cooperation in government. They help and supervise in the formation and running of cooperative organizations, which are meant to collect and channelize people to form cooperative organizations to help themselves in managing their affairs such as cooperative banks, cooperative societies which cater to needs of people
- Industry is a place where the successful manufacturing of a product is the outcome of the collective efforts, cooperation and dedication of a team of engineers with expertise along with skilled workers. An engineer basically has to learn the art to communicate, coordinate, cooperate with various other units to complete a task;

Moral story for Cooperation

Once upon a time, there was a flock of doves that flew in search of food led by their king. One day, they had flown a long distance and were very tired. The dove king encouraged them to fly a little further. The smallest dove picked up speed and found some rice scattered beneath a banyan tree. So all the doves landed and began to eat.

Suddenly a net fell over them and they were all trapped. They saw a hunter approaching carrying a huge club. The doves desperately fluttered their wings trying to get out, but to no avail. The king had an idea. He advised all the doves to fly up together carrying the net with them. He said that there was strength in unity.

Each dove picked up a portion of the net and together they flew off carrying the net with them. The hunter looked up in astonishment. He tried to follow them, but they were flying high over hills and valleys. They flew to a hill near a city of temples where there lived a mouse that could help them. He was a faithful friend of the dove king.

When the mouse heard the loud noise of their approach, he went into hiding. The dove king gently called out to him and then the mouse was happy to see him. The dove king explained that they had been caught in a trap and needed the mouse's help to gnaw at the net with his teeth and set them free.

The mouse agreed saying that he would set the king free first. The king insisted that he first free his subjects and the king last. The mouse understood the king's feelings and complied with his wishes. He began to cut the net and one by one all the doves were freed including the dove king.

They all thanked the mouse and flew away together, united in their strength.

1.17. Commitment

"The quality of a person's life is in direct proportion to their commitment to excellence, regardless of their chosen field of endeavour" - Vince Lambradi

"Never, never, never, give up" – Winston Churchill

- Every individual when grown up has to perform one or other duty, not only for his livelihood but even for the betterment of social and nation conditions.

- It starts from the student's day. He has to be committed to studying with devotion. This is a basic requirement for any profession. For example, a design engineer shall exhibit a sense of commitment, to make his product or project designed a beneficial contribution to the society. Only when the teacher (Guru) is committed to his job, the students will succeed in life and contribute 'good' to the society. The commitment of top management will naturally lead to committed employees, whatever may be their position or emoluments. This is bound to add wealth to oneself, one's employer, society, and the nation at large. A solider should be committed to his duties to save the nation. A farmer should be dedicated to farming then only he can feed all of without scarcity of food.
- Commitment is willingness to give your time and energy to something that you believe in, or a promise or firm decision to do something.
- Commitment means acceptance of the responsibilities and duties and cooperation means help and assistance. By developing team commitment and cooperation in a work team you are assisting the team to meet its goals and objectives. Work teams that are committed and cooperative are more likely to achieve the goals the business has set.

Moral story for Commitment – Story of Geppetto - more joy than any other famous puppet-maker ever got from any of their creations.

There was once a young man who liked puppets so much that he became an apprentice to a master puppet-maker. Sadly, the young man was very clumsy, and his teacher and the other apprentices were always telling him he had no ability when it came to making puppets, and that he would never amount to anything.

Even so, he enjoyed it so much that he worked day after day to improve. Despite his efforts, they would always find something wrong with the puppets he had made, and they ended up throwing him out of the workshop.

He wasn't going to give up, so the young man decided that from then on he would spend all his time making just one kind of puppet. On he went, and whenever he found a fault in his puppet he would abandon it and start again right from square one. The years passed, and with each new attempt his puppet became a little bit better. By now, his puppet was much better than anything his old fellow apprentices could make, but he kept making improvements, seeking perfection. Living like that, the man wasn't making any money, and many people laughed at how poor he was.

By the time he was an old man, his puppet was truly wonderful. So much so, that finally one day, after so many years of work, he finished work on his puppet, and said: "I can't find anything wrong with it. This time it is perfect", and for the first time in all those years, instead of abandoning his puppet, he put it up on the shelf, feeling truly satisfied and happy.

1.18. Empathy

Definition:

- **"The ability to imagine oneself in anther's place and understand the other's feelings, desires, ideas and actions"**
- Empathy is closely related to the ability to read other people's emotion. It depends on one's capacity to put oneself in the other person's place and to experience an appropriate emotional response. It also to expertise that emotion our self.

Elements of Empathy

- Ability to imagine
- Self awareness or self consciousness
- The existence of an available other
- The existence of accessible feelings, desires, ideas and representations of actions or their outcomes both in empathizing self and others.

Characteristics of Empathy

1. **Understanding others:** It means sensing others feelings and perspectives, and taking active interest in their welfare.
2. **Service orientation:** It is anticipation, recognition and meeting the needs of the clients or customers.

3. **Developing others:** This means identification of their needs and bolstering their abilities. In developing others, the one should inculcate in him the 'listening skill' first.
   Communication = 22% reading and writing + 23% speaking + 55% listening
   One should get the feedback, acknowledge the strength and accomplishments, and then coach the individual, by informing about what was wrong, and giving correct feedback and positive expectation of the subject's abilities and the resulting performance.
4. **Leveraging diversity (opportunities through diverse people):** This leads to enhanced organizational learning, flexibility, and profitability.
5. **Political awareness:** It is the ability to read political and social currents in an organization.

The benefits of empathy include:

- **Empathy connects people together**: Good customer relations (in sales and service, in partnering).
- Empathy Heals: Caring - Harmonious labour relations (in manufacturing).
- Empathy builds Trust
- Empathy closes the loop: Good vendor-producer relationship (in partnering.) Through the above three, we can maximize the output and profit, as well as minimizing the loss. While dealing with customer complaints, empathy is very effective in realizing the unbiased views of others and in admitting one's own limitations and failures. According to Peter Ducker, purpose of the business is not to make a sale, but to make and keep a customer. Empathy assists one in developing courage leading to success.

Empathy is the ability to *experience* the feelings of another person. It goes beyond sympathy, which is caring and understanding for the suffering of others. Both words are used similarly and often interchangeably (incorrectly so) but differ subtly in their emotional meaning.

	Empathy	**Sympathy**
Definition	Understanding what others are feeling because you have experienced it yourself or can put yourself in their shoes.	Acknowledging another person's emotional hardships and providing comfort and assurance.
Example	"I know it's not easy to lose weight because I have faced the same problems myself."	"Trying to lose weight can often feel like an uphill battle."
Relationship	Personal understanding	Understanding the experience of others
Nursing context	A doctor relating with a patient because he or she has been in a similar situation or experience	Doctors comforting patients or their families
Scope	Personal; it can be one to many in some circumstances	From either one to another person or one to many (or one to a group).

Moral story for Empathy

The following is a fantastic, true story from a teacher:

"I work as a resource room teacher with children who have learning disabilities. A few years ago a young boy began taking lessons in my resource room. I could not figure out what had brought him to seek my help. He clearly had no difficulty with his lessons and did well on all his tests. Yet, time after time he consistently came to my resource room for his lessons. I was determined to find his area of weakness but, as hard as I tried, I could not find any type of learning disability or difficulty. Finally, out of frustration, I took him aside and told him I could not continue giving him lessons. It was a waste of his time and his parent's hard earned money and he clearly did not need any sort of remedial help. The boy turned to me and said, " I will tell you why I am here but I am asking you not to tell anyone else. I have a friend with a learning disability. Our teacher told him that he needed remedial classes in the resource room. He was so embarrassed to be singled out as having to go to your classes. I told him that it was no big deal and that I also take remedial classes. That is why I come to you- so that my friend will not be embarrassed".

1.19. Self Confidence

"Success comes to those who dare and act, it seldom comes to the timid" – Jawharlal Nehru

- Certainty in one's own capabilities, values, and goals, is self-confidence. These people are usually positive thinking, flexible and willing to change. They respect others so much as they respect themselves.
- Self-confidence is positive attitude, wherein the individual has some positive and realistic view of himself, with respect to the situations in which one gets involved. The people with self-confidence exhibit courage to get into action and unshakable faith in their abilities, whatever may be their positions. They are not influenced by threats or challenges and are prepared to face them and the natural or unexpected consequences.
- The self-confidence in a person develops a sense of partnership, respect, and accountability, and this helps the organization to obtain maximum ideas, efforts, and guidelines from its employees.

The people with self-confidence have the following characteristics:

a) A self-assured standing,
b) Willing to listen to learn from others and adopt (flexibility),
c) Frank to speak the truth, and
d) Respect others' efforts and give due credit.

The factors that shape self-confidence in a person are:

a) Heredity (attitudes of parents) and family environment (elders),
b) Friendship (influence of friends/colleagues),
c) Influence of superiors/role models, and
d) Training in the organization (e.g., training by Technical Evangelists at Infosys Technologies).

The following methodologies are effective in developing self-confidence in a person:

a. Encouraging SWOT analysis. By evaluating their strength and weakness, they can anticipate and be prepared to face the results.
b. Training to evaluate risks and face them (self-acceptance).
c. Self-talk. It is conditioning the mind for preparing the self to act, without any doubt on his capabilities. This make one accepts himself while still striving for improvement.
d. Study and group discussion, on the history of leaders and innovators (e.g., Sam Walton of Wal-Mart, USA).

Moral Story for self confidence and courage

A tired bird landed on a branch. The bird rested, enjoying the view from the branch and the protection it offered from dangerous animals. Just as the bird became used to the branch and the support and safety it offered, a strong wind started blowing, and the tree swayed with such intensity that it seemed the branch would snap in half. But the bird was not worried for it knew two important truths. The first truth – *even without the branch it was able to fly, and thus remain safe through the power of its own two wings.* The second truth – *it also knew that there are many other branches upon which it can temporarily rest.* This small story tells us a lot about our own self-confidence and courage.

1.20. Character

- Character traits are all the aspects of a person's behaviour and attitudes that make up that person's personality. Everyone has character traits, both good and bad.
- Some character traits have to do with your underlying values or beliefs. Some examples of these types of character traits include: Religious, Honest, Loyal, Devoted, Loving, Kind, Sincere, Devoted, Ambitious, Satisfied, Happy, Faithful, Patient, Determined, Persistent, Adventurous, Homebody, Considerate, Cooperative, Cheerful, Optimistic, Pessimistic and Funny.
- Some character traits can be bad, and you may not want these traits associated with you. Some examples of these types of character traits include: Dishonest, Disloyal, Unkind, Mean, Rude, Disrespectful, Impatient, Greedy, Angry, Pessimistic, Repugnant, Cruel, Unmerciful, Wicked, Obnoxious, Malicious, Grumpy, Quarrelsome, Caustic, Selfish, Unforgiving
- A leader or person who likes to be in charge may have the following character traits: Domineering, Boorish, Persuasive, Ambitious, Bossy, Disparaging, Picky, Sly, Cold-hearted, Rude, Self-centred, Conceited
- Some character traits can be consciously developed, learned or acquired. For example, character traits that you may consciously choose to learn or adopt include: Educated or Informed

- Some character traits for children include: Playful, Zany, Active, Wild, Silly, Affectionate, Funny, Rough, Talkative, Rowdy, Smart, Fidgety, Shy, Lively, Submissive, Stubborn

Education and Character

The aim of education is not only the cultivation of the intellect but also the formation of moral character. Increased intelligence or physical skill may as easily be employed to the detriment or benefit of the community, if not accompanied by improved will. It is the function of ethics to determine the ideals of human character. The theory and science of education are to study the processes by which that end may be attained.

Building Character in the Workplace

Managers have to influence and employ creative means of stressing the importance of good character in the workplace, in the following ways:

a) **Employee Hiring, Training, and Promotion Activities:**
   a) Institute and adopt an organization policy statement to positive character in the workplace. For example, commitment to civility pledges. This may be communicated through printing on the back of the business cards of the employees.
   b) Prominently and explicitly include character considerations in recruiting procedures, during interviews and in the hiring deliberations.
   c) Emphasize the importance of character and adherence to the 'six pillars' of character in orientation, initial job training, and during in-service training. The six pillars of character are the ethical values, such as: trustworthiness, respect, responsibility, fairness, caring and citizenship. Respect means showing high regard for self, others, authority, property and country. It includes showing appreciation for cultural diversity by valuing all people as human beings. Responsibility is
      i. being accountable for one's actions,
      ii. being dependable in carrying out obligations and duties,
      iii. being reliable and consistent in word and action, and
      iv. being committed to community development. Integrity or fairness means showing the inner strength and courage to be truthful, trustworthy, fair and honest in all things. It includes acting justly and honorably. Caring means being kind, considerate, courteous, helpful, friendly and generous to others, and being compassionate by treating others as you would like to be treated. Citizenship means accepting and adopting civic rights and duties as a citizen of the country.
   d) Include evaluation of fundamental character values such as honesty, promise keeping, accountability, fairness, and caring, in appraisals/reviews.
   e) Institute recognition and reward system for the employees who exemplify the positive character. For example, awards and medals.
   f) Think of your employees, especially the younger ones, as people whose personal and work values will be influenced by what you expect of them and how you treat them.
   g) Think of your employees as present or future mentors, coaches, and volunteers.

2. Internal Communication

Use internal communication channels to create a friendly environment that praises positive role modeling at the workplace and in the community by encouraging voluntarism, and mentoring, e.g., through

a) Internal newsletters,
b) Workplace posters in canteens and recreation rooms,
c) Mailers, and
d) Electronic mails.

3. External Communication

In relations with customers, vendors and others, consciously communicate affirming messages about character and ethics, such as

(a) Advertise and market honoring consensual values (the six pillars),
(b) Assure that none of your products and services undermines character building,
(c) Include positive messages about voluntarism and celebrate, and
(d) 'Character counts' week in advertising, billings and other mailers.

1.21. Spirituality

- Spirituality is a way of living that emphasizes the constant awareness and recognition of the spiritual dimension (mind and its development) of nature and people, with a dynamic balance between the material development and the spiritual development. This is said to be the great virtue of Indian philosophy and for Indians. Sometimes, spirituality includes the faith or belief in supernatural power/ God, regarding the worldly events. It functions as a fertilizer for the soil 'character' to blossom into values and morals.
- Spirituality includes creativity, communication, recognition of the individual as human being (as opposed to a life-less machine), respect to others, acceptance (stop finding faults with colleagues and accept them the way they are), vision (looking beyond the obvious and not believing anyone blindly), and partnership (not being too authoritative, and always sharing responsibility with others, for better returns).
- Spirituality is motivation as it encourages the colleagues to perform better. Remember, lack of motivation leads to isolation. Spirituality is also energy: Be energetic and flexible to adapt to challenging and changing situations. Spirituality is flexibility as well. One should not be too dominating. Make space for everyone and learn to recognize and accept people the way they are. Variety is the order of the day. But one can influence their mind to think and act together. Spirituality is also fun. Working is okay, but you also need to have fun in office to keep yourself charged up. Tolerance and empathy are the reflections of spirituality. Blue and saffron colors are said to be associated with spirituality.
- Creativity in spirituality means conscious efforts to see things differently, to break out of habits and outdated beliefs to find new ways of thinking, doing and being. Suppression of creativity leads to violence. People are naturally creative. When they are forced to crush their creativity, its energy turns to destructive release and actions. Creativity includes the use of color, humor and freedom to enhance productivity. Creativity is fun. When people enjoy what they do, it is involvement. They work much harder.

Spirituality in the Workplace

Spirituality is promoted in the workplace by adhering to the following activities:

a) Verbally respect the individuals as humans and recognize their values in all decisions and actions.
b) Get to know the people with whom you work and know what is important to them. Know their goals, desires, and dreams too.
c) State your personal ethics and your beliefs clearly.
d) Support causes outside the business.
e) Encourage leaders to use value-based discretion in making decisions.
f) Demonstrate your own self-knowledge and spirituality in all your actions.
g) Do unto others as you would have them do unto you.

Spirituality for Corporate Excellence

The spiritual traits to be developed for excellence in corporate activities are listed as follows:

a) **Self-awareness** — Realization of self-potential. A human has immense capability but it needs to be developed.
b) **Alertness** in observation and quickness in decision making, i.e., spontaneity which includes quick reflexes, no delay but also no hasty decisions.
c) **Being visionary and value based** — This includes an attitude towards future of the organization and the society, with clear objectives.
d) **Holism** — Whole system or comprehensive views and interconnected with different aspects. Holistic thinking, which means the welfare of the self, family, organization and the society including all other living beings and environment.
e) **Compassion** — Sympathy, empathy and concern for others. These are essential for not only building the team but also for its effective functioning.
f) **Respect for diversity** — It means search for unity in diversity i.e., respect others and their views.
g) **Moral Autonomy** — It means action based on rational and moral judgment. One need not follow the crowd or majority i.e., band-wagon effect.
h) **Creative thinking and constant reasoning** — Think if we can do something new and if we can improve further?

i) **Ability to analyze and synthesize** — Refrain from doing something only traditional.
j) **Positive views of adversity** — Make adversities one's source of power—a typical Karma yogi's outlook! Every threat is converted into opportunity.
k) **Humility -** The attitude to accept criticism (it requires courage!) and willing to correct. It includes modesty and acknowledging the work of colleagues.
l) **Sense of vocation** — Treat the duty as a service to society, besides your organization.

1.22. Introduction to Yoga and meditation for professional excellence and stress management

YOGA

- Yoga is an ancient discipline designed to bring balance and health to the physical, mental, emotional, and spiritual dimensions of the individual, when adopted as a way of life, yoga improves physical, mental, intellectual, and spiritual health.
- Yoga offers an effective method of managing and reducing stress, anxiety, and depression, and numerous studies demonstrate the efficacy of yoga on mood-related disorders.
- Yoga is often depicted metaphorically as a tree and comprises eight aspects, or limbs: yama (universal ethics), niyama (individual ethics), asana (physical postures), pranayama (breath control), pratyahara (control of the senses), dharana (concentration), dyana (meditation), and samadhi (bliss)

Tree of Yoga

- Roots: Foundation for living honourably and clearly
- Trunk: Establishing a base of purity in one's body and mind
- Branches: Strong and flexible to move with the wind of life
- Leaves: Drawing in life force through the exchange of breath
- Bark: Protecting the tree from outer elements and preventing its essence from flowing outward
- Sap: Juice which carries the energy on this inward journey, links the whole tree as one
- Fruit: The essence of the tree
- Yoga is a complete process of perfection of man by developing his personality so that he may reach his ultimate goal, thereby fulfilling the purpose of his birth. **Value of Yoga:**
- Yoga is a science of life to develop the sixth sense to its fullness and to enable and equip man to enjoy peaceful and blissful life. It is essentially an art of understanding all about the soul, which is one of the life force and realizing its relationship with the body, the society, the world and the universe, maintaining its harmony and finally getting it merged with the universal soul.
- In nature, man is an unique living being in that he alone is gifted with sixth sense. The sixth sense is a higher level of mind which is able o understands its own existence and functions. It is a divine meter measuring all the functions of the universe and understanding oneness among multiplicity and unit in diversity.

Purpose of Yoga:

- **For the liberation of the soul,**

(i) The attachment with material enjoyments should be neutralized and full satisfaction should be achieved, and
(ii) The impressions of sins should be obliterated.

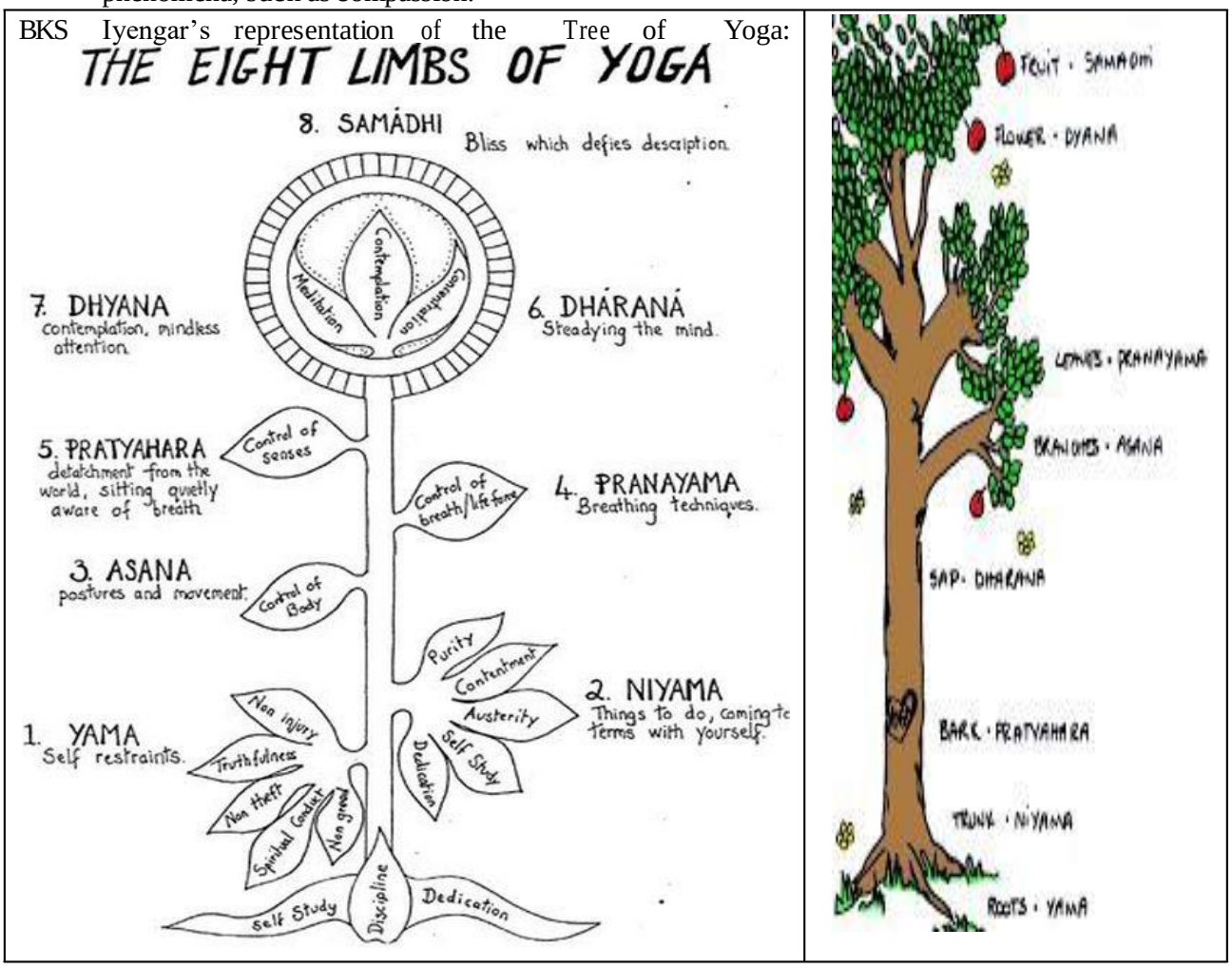
In order to attain these two, Soul Consciousness is very important.

- Yoga provides all the facilities and opportunities for improving the unsolved awareness to get satisfaction with worldly enjoyment and also to obtain detachment and eliminate the impressions of sins by streamlining the activities of the mind.
- Yoga will help man in the performance of all his duties in harmony with the Law of Nature and the sentiments and conventions of the society, enable him to lead a successful life and to achieve satisfaction and peace of sharpening his intellect, cultivating constant awareness and strengthening the will, streamlining the mind and moralizing the behaviour. Yoga is a well-balanced and perfect process for success and peace in life.
- **Meditation** is a practice in which an individual trains the mind or induces a mode of consciousness, either to realize some benefit or for the mind to simply acknowledge its content without becoming

identified with that content, or as an end in it. Meditation often involves an internal effort to self-regulate the mind in some way.

- Meditation is often used to clear the mind and ease many health concerns, such as high blood pressure, depression, and anxiety. Meditation may involve generating an emotional state for the purpose of analyzing that state such as anger, hatred, etc. or cultivating a particular mental response to various phenomena, such as compassion.

BKS Iyengar's representation of the Tree of Yoga:



The role of yoga in stress management

- Stress can also be defined as the harmful physical and emotional responses that occur when the requirements of the job do not match the capabilities, resources, or needs of the worker.
- Job stress can lead to poor health and even injury. Hence we can say that stress is a silent killer, and prolonged exposure to stress may exert harmful effects on physical, psychological, and behavioural well-being of an individual.
- According to the National Institute for Occupational Safety and Health, 80% of workers experience job stress.

IMPACT OF STRESS

- One of the studies quoted that stress-related disorders evolve gradually through four recognizable stages.

1. In the first, psychological changes such as anxiety, irritability, and insomnia arise, due to over-stimulation of the sympathetic nervous system.
2. In the second stage symptoms such as high blood pressure, elevated heart rate, and increased intestinal motility surface.

3. In the third stage, a more profound physical or biochemical imbalance sets in,
4. In the final fourth stage, irreversible symptoms that often require surgical or long-term management appear.

- Increased sympathetic activation and the release of stress hormones, including adrenaline, lead to increases in heart rate, blood pressure, breathing, body temperature, and muscle tension.
- In contrast, the relaxation response has been proposed as an remedy to stress; relaxation decreases heart rate, breathing, body temperature, and muscle tension.
- Similar to stress in the workplace, college students are also often impacted by stress. Academic stress can result from many different imperative stressors, such as final grades, term papers, examinations, and excessive homework. Stress has exhibited a negative correlation with cognitive performance, thus negatively impacting academic performa

EFFECT OF YOGA IN STRESS

- Yoga significantly decreases heart rate and systolic and diastolic blood pressure.
- Studies suggest that yoga reverses the negative impact of stress on the immune system by increasing levels of immunoglobulin A as well as natural killer cells.
- Yoga has been found to decrease markers of inflammation such as high sensitivity C-reactive protein as well as inflammatory cytokines such as interleukin-6 and lymphocyte-1B. These studies suggest that yoga has an immediate quieting effect on the SNS-HPA axis response to stress. While the precise mechanism of action has not been determined, it has been hypothesized that some yoga exercises cause a shift toward parasympathetic nervous system dominance, possibly via direct vagal stimulation. Shapiro et al noted significant reductions in low-frequency heart rate variability (HRV)—a sign of sympathetic nervous system activation—in depressed patients following an 8-week yoga intervention.
- Regardless of the path physiologic pathway, yoga has been shown to have immediate psychological effects: decreasing anxiety and increasing feelings of emotional, social, and spiritual well-being.
- Several literature reviews have been conducted that examined the impact of yoga on specific health conditions, including cardiovascular disease, metabolic syndrome, diabetes, cancer, and anxiety.
- Another study has shown improvement of mental health of both the young and seniors by reducing stress through yoga. Yoga can be wisely applied in welfare programs to improve the quality of life in all age groups.
- Yogic science includes yogasanas (postures), pranayama (breathing practices), dhyana (meditation), and relaxation techniques which benefit human beings at every level.

Steps used to relive the stress:

- Find a quiet, relaxing atmosphere
- Find a comfortable position
- Take in a deep breath
- Try to clear your mind and avoid distractions, if you can -
- Imagine yourself in a happy place -
- Close your eyes continue to breathe deeply, and imagine all your body slowing down
- Take your time

UNIT II ENGINEERING ETHICS

Senses of "Engineering Ethics‟ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg‟s theory – Gilligan‟s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

2.1. What is Ethics?

- ✓ The term 'ethics' is derived from the Greek word ‘ethos’, which meant 'customs'.
- ✓ Ethics· is the study of the characteristics of morals.
- ✓ First of all, ethics is the quest for and the understanding of the good life, living well, a life worth living.
- ✓ In a wider perspective, ethics is putting every activity and goal In its place. It is concerned with knowing what Is worth doing and what Is not worth doing; knowing what is worth wanting and knowing what is not worth wanting.
- ✓ Ethics according to the Oxford advanced dictionary means moral principles that govern or Inftuence • person's behavior.
- ✓ Ethics is defined as the discipline dealing with what is good and bad with moral duty and obligation (responsibility)
- ✓ Some of the universal accepted ethical principles are :
  - Integrity, honesty, confidentiality, discipline, humanity, responsibility, accountability, discipline, loyalty, diligence, wisdom, courage, collegiability, conscientiousness, competency, temperance, justice, etc.
- ✓ **Various Disciplines Of Ethics**

The term 'ethics' is a broad, general term. In practice, there different disciplines of ethics. They are:

- ✓ **Personal Ethics**
  - Personal ethics is concerned with the rules by which an individual lives his or her personal life.
  - It also deals with how we treat others in our day-to-day lives.
- ✓ **Business Ethics**
  - Business ethics is concerned with truth and justice and has a variety of aspects such as the expectation of society, fair competition, advertising, public relationa, social responsibilities, consumer autonomy, and corporate behavior .
  - It involves choices on an organization level rather than a personal level.
- ✓ **Engineering Ethics**
  - Engineering ethics is concerned with the rules and standards governing the conduct of engineers in their role as professionals.
  - It is a body of philosophy guiding tt,e ways that engineers should conduct themselves in their professional capacity.
- ✓ **Medical Ethics**
  - ✓ Medical ethics is concerned with the rules and standards governing the conduct **of doctors and other medical practitioners in their role as professionals**
- ✓ **Legal Ethics**
  - ✓ Legal ethics is concerned with the codes that guide the professional conduct of lawyers, judges, etc.

- ✓ Accounting Ethics
  - ✓ Accounting ethics is concernedwith the codes that guide the professional conduct of accountants.

2.2. What is engineering ethics?

- ✓ **Engineering ethics Is concerned with:**
  - The study of the moral issues and decisions confronting mdlvidual and organizations engaged in engineering field; and
  - The study of related issues about the moral ideals, characters, policies, an . relationships of people and corporations involved In technological activity
  - It refers to the ethical obligations that engineers have to follow because of their professional status.
  - It not only emphasizes how engineers should conduct themselves; it also encompasses how the engineers ought to be having in their professional world
  - Definition: Engineering ethics may be defined as the identification, study and resolution of ethical problems occurring in the practice of the engineering profession .
  - The concept of engineering ethics is not applicable only for engineers. It can also be applied to others who engage in any technological enterprises, such as scientists, technicians, technical writers, production staffs, supervisors, sales staffs, doctors, lawyers, and the general public.
- ✓ **Engineering Ethics Vs Professional Ethics**
  - In general, the terms engineering ethics and professional ethics are used interchangeably. But the professional ethics is wider in scope than the engineering ethics. In fact, the engineering ethics is a part of professional ethics.
  - Professional ethics is the discipline aimed at understanding the moral values that ought to guide all professional practices, including engineering, medicine, law and other practices. But the engineering ethics refers to the set of specific moral problems and issues related to engineering profession only
- ✓ **Why it is necessary for Engineering students to study Engineering Ethics?**
  - **Stimulating the moral Dimension**
    - It is to stimulate the moral imagination of engineering students
    - Imagination is necessary for Engineers in anticipating the consequences of actions as professionals and in finding solutions to ethical problems encountered in their professional life
  - **Recognizing ethical issues**
    - **The** ethical problems encountered in engineering practice, often are very complex. Also they involve conflicting ethical principles
  - **Developing analytical skills**
    - The technical and analytical skills required for analyzing moral issues are quite different than that are exercising good engineering projects
    - While analyzing moral issues, one requires clear thinking about concepts such as utility, justice, rights, duties, and respect for persons
    - The aim of engineering ethics is to train the engineers to analyze complex problems.
  - **Drawing out of sense of responsibility**

- The engineering ethics course encourages the engineers to desire to fulfill ethical ideals rather than ethical requirements
- Ethical requirements Vs Ethical Ideals: Ethical requirements are basic obligations and duties. Thus engineering ethics promotes a sense of responsibility and the moral autonomy of future engineers.

- **Addressing unclarity, uncertainty, and disagreement**
  - The engineering ethics helps the engineers In addressing unclarity, uncertainty, and disagreement about moral issues.
  - As we know, resolving ethical issues expose a certain amount of vagueness, ambiguity, uncertainty, and disagreement. The study of engineering ethics helps engineers to learn to resolve these problems in the most ethical manner.

- ✓ **Note:** ***Engineering ethics is also referred as 'prevention ethics'. Similar to the concept of preventive medicine, prevention ethics deals with anticipating all sorts of ethical Issues and preventing them from occurring.***
- ✓ **The Scope of engineering ethics are twofold:**
  - Ethics of the workplace which involves the co-workers and employees in an organization.
  - Ethics related to the product or work which involves the transportation, warehousing, and use, besides the safety of the end product and the environment outside the factory.

2.3. Senses or Dimensions of Engineering Ethics

Four senses:

- ✓ When we interpret Ethics is an activity and area of inquiry. It is the activity of understanding moral values, resolving moral issues and the area of study resulting from that activity. It can be defined as
  - **Engineering ethics is an activity and discipline aimed at understanding the moral values that ought to guide engineering practices, resolve moral issues in Engineering, and Justifying moral judgments concerning Engineering**
- ✓ When we speak of ethical problems, issues and controversies, we mean to distinguish them from non moral problems. It can be defined as:
  - **Engineering ethics refer to set of specific moral problems and issues related to engineering**
- ✓ When Ethics is used to refer to the particular set of beliefs, attitudes and habits that a person or group displays concerning moralities. It may be defined as:

- **Ethics has widely accepted codes and standards of conduct, which are to be followed by the group of Engineers and Engineering Societies**

✓ When Ethics and its grammatical variants can be used as synonyms for 'morally correct'. It may be defined as:

- **Engineering ethics is concerned with the set of justified moral principles of obligation, rights and ideals that are to be followed by Engineers.**

2.4. Morality And Moral Reasons

2.4.1. What Is Morality?

The word morality is concerned with:

- ✓ What morally ought or ought not to be given in a given solution
- ✓ What morally right or wrong about the handling of the situation; and/or
- ✓ What is morally good or bad about the people, policies and ideals involved in it
- ✓ **According to the oxford dictionary, morally means principles concerning right and wrong or good and bad behavior**
- ✓ **Moral reasons are required to support an act (or an ideal) to be called as morally right act (or an ideal is moral)**

2.4.2. What are moral reasons?

Some of the important moral reasons include:

- Respecting others and ourselves,
- Respecting the rights of others;
- Keeping promises to others;
- Avoiding unnecessary offence and pain to others:
- Avoiding cheating and dishonesty;
- Showing gratitude for favor to others; and
- Encouraging teamwork,

2.4.3. Variety of moral issues

2.4.3.1. Approaches to Engineering ethics

✓ **There are conventionally two approaches in the study of ethics:**

✓ Micro-ethics which deals with decisions and problems of individuals, professionals, and companies.

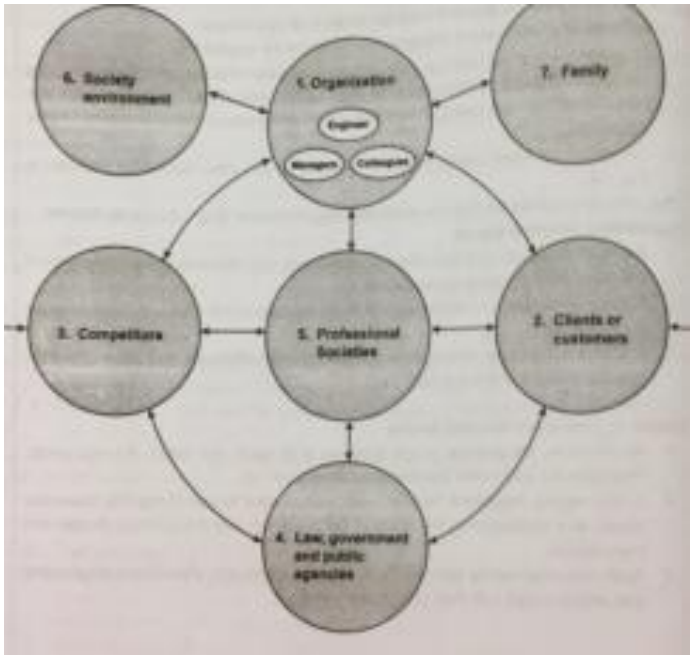
✓ Macro-ethics which deals with the societal problems on a regional/national level. For example, global issues, collective responsibilities of groups such as professional societies and consumer groups

✓ ***Moral Problems In Engineering***

- Engineers carry out various activities and decision making exercises involving technical, financial, managerial, environmental and ethical issues. The variety of moral issues and their relationship with the issues are depicted below:
- **Organizational oriented issues.**
  - Being an employee to a firm, the engineer has to work towards the achievement of the objectives of his /her organization
  - Engineers have to give high priority to the benefits of the organization than one's own benefits
  - Engineers should be able to work collectively with colleagues and other members in order to achieve firm's goal
- Clients and customers oriented issues

- Engineers have a major role to play in identifying the customers voice and incorporating the voice of the customer into product design and manufacture
- Apart from technical issues he has to face other moral and ethical issues with their clients/customers

- **Competitors oriented issues**
  - **In** order t withstand in the market, engineers should produce things better than the competitor
  - He should not practice cut-throat competition. They should follow professionalism
  - He should go with safety, health and welfare of their clients/ customers in the performance of their professional duties
- **Law , government and public agencies oriented issues**
  - Engineers should obey and voluntarily comply with all the government rules and regulations related to them
  - They should also respect and honestly practice all other similar laws, policies and regulations
- **Professional societies oriented issues**
  - Engineers should follow strictly the code of ethics by various professional societies such as National Society of Professional Engineers (NSPE), the Institute of Electrical and electronics Engineers(IEEE),and American Society of Mechanical Engineers (ASME).
  - The professional code of ethics reflect the basic norms of conduct that exist within a particular professional and provide guidance
- **Social and Environmental Oriented Issues:**
  - Engineers should be dedicated to the protection of the public health, safety and welfare
  - He should also be aware as role as experimenters. They should be committed in protecting the environment. They should not involve in unethical environmental activities such as misusing scarce resources and polluting them
- **Family oriented issues**
  - Engineers do have family responsibility and he has to take care of their needs. But should not take any decisions for their own benefits at the cost of public, clients or employers



(Some Examples)

- **Resource Crunch**
  - Due to pressure, through time limits, availability of money or budgetary constraints, and technology decay or obsolescence. Pressure from the government to complete the project in time (e.g., before the elections), reduction in the budget because of sudden war or natural calamity (e.g., Tsunami) and obsolescence due technology innovation by the competitor lead to manipulation and unsafe and unethical execution of projects.
  - Involving individuals in the development of goals and values and developing policies that allow for individual diversity, dissent, and input to decision-making will prevent unethical results.
- **Opportunity**
  - Double standards or behavior of the employers towards the employees and the public. The unethical behaviors of World Com (in USA), Enron (in USA as well as India) executives in 2002 resulted in bankruptcy for those companies,
  - Management projecting their own interests more than that of their employees. Some organizations over-emphasize short-term gains and results at the expense of themselves and others,
  - Emphasis on results and gains at the expense of the employees, and
  - Management by objectives, without focus on empowerment and improvement of the infrastructure.
  - This is best encountered by developing policies that allow 'conscience keepers' and whistle blowers and appointing ombudsman, who can work confidentially with people to solve the unethical problems internally.
- **Attitude**

  Poor attitude of the employees set in due to
  - Low morale of the employees because of dissatisfaction and downsizing, (b) Absence of grievance redressal mechanism,
  - Lack of promotion or career development policies or denied promotions,
  - Lack of transparency,

- Absence of recognition and reward system, and
- Poor working environments.
- Giving ethics training for all, recognizing ethical conduct in work place, including ethics in performance appraisal, and encouraging open discussion on ethical issues, are some of the directions to promote positive attitudes among the employees.
- To get firm and positive effect, ethical standards must be set and adopted by the senior management, with input from all personnel.
- An inspector discovered faulty construction equipment and applied a violation tag, preventing its use. The supervisor, a construction manager viewed the case as a minor abrasion of the safety regulations and ordered the removal of the tag to speed up the project. When the inspector objected to this, he was threatened with disciplinary action.
- An electric utility company applied for a permit to operate a nuclear power plant. The licensing agency was interested in knowing what emergency measures had been established for humans safety in case of reactor malfunctioning. The utility engineers described the alarm system and arrangements with local hospitals for treatment. They did not emphasize that this measures applied to plant personnel only and that they had no plans for the surrounding population. When enquired about their omission, they said it was not their responsibility.
  - A chemical plant dumped wastes in a landfill. Hazardous substances found their way into the underground water table. The plant's engineers were aware of the situation but did not change the method of disposal because their competitors did it the same cheap way, and no law explicitly forbade the practice.
  - Electronics Company ABC geared up for production of its own version of a popular new item. The product was not yet ready for sale, but even so, pictures and impressive specifications appeared in advertisements. Prospective customers were led to believe that it was available off the shelf and were drawn away from competing lines.

2.5. Types of Inquiry

- The three types of inquiries, in solving ethical problems are: normative inquiry, conceptual inquiry,and factual or descriptive inquiry.
- The three types of inquiries are discussed below to illustrate the differences and preference.

2.5.1.Normative Inquiry

It seeks to identify and justify the morally-desirable norms or standards that should guide individuals and groups. It also has the theoretical goal of justifying particular moral judgments. Normative questions are about what ought to be and what is good, based on moral values. For example,

- How far does the obligation of engineers to protect public safety extend in any given situation?
- When, if ever, should engineers be expected to blow whistle on dangerous practices of their employers?
- Whose values ought to be primary in making judgment about acceptable risks in design for a public transport system or a nuclear plant? Is it of management, senior engineers, government, voters or all of them?
- When and why is the government justified in interfering with the organisations?
- What are the reasons on which the engineers show their obligations to their employees or clients or the public?

2.5.2.Conceptual Inquiry

It is directed to clarify the meaning of concepts or ideas or principles that are expressed by words or by questions and statements. For example,

- What is meant by safety?
- How is it related to risk?
- What is a bribe?
- What is a profession?

o When moral concepts are discussed, normative and conceptual issues are closely interconnected.

2.5.3.Factual or Descriptive Inquiry

It is aimed to obtain facts needed for understanding and resolving value issues. Researchers conduct factual inquiries using mathematical or statistical techniques. The inquiry provide important information on business realities, engineering practice, and the effectiveness of professional societies in fostering moral conduct, the procedures used in risk assessment, and psychological profiles of engineers. The facts provide not only the reasons for moral problems but also enable us to develop alterative ways of resolving moral problems. For example,

- How were the benefits assessed?
- What are procedures followed in risk assessment?
- What are short-term and long-term effects of drinking water being polluted? and
- Who conducted the tests on materials?

2.6. **Moral Dilemmas**

2.6.1.**Definition**

a. Dilemmas are situations in which moral reasons come into conflict, or in which the application of moral values are problems, and one is not clear of the immediate choice or solution of the problems.

b. Moral reasons could be rights, duties, goods or obligations. These situations do not mean that things had gone wrong, but they only indicate the presence of moral complexity. This makes the decision making complex.

c. For example, a person promised to meet a friend and dine, but he has to help his uncle who is involved in an accident — one has to fix the priority.

2.6.2.Causes of Moral Dilemmas

d. There are some difficulties in arriving at the solution to the problems, in dilemma. The three complex situations leading to moral dilemmas are:

a. **The problem of vagueness:** One is unable to distinguish between good and bad (right or wrong) principle. Good means an action that is obligatory. For example, code of ethics specifies that one should obey the laws and follow standards. Refuse bribe or accept the gift, and maintain confidentiality

Example: consider an engineer, starting a new assignment as quality inspector checking the incoming raw materials/spare parts from the suppliers. Suppliers offer gift during festival occasions. This situation causes moral dilemma to engineers whether to accept the gift or whether it will be treated as bribe and whether it will create conflict of interest. Thus this problem of vagueness – unclarity, causes moral dilemma

b. **The problem of conflicting reasons:** One is unable to choose between two good moral solutions. One has to fix priority, through knowledge or value system.

Example: let us examine the space shuttle Challenger explosion, focusing on the dilemma faced by the Engineer cum Manager Bob Lund. He had following issues:

- **Launching the Challenger** space shuttle despite there was an unknown probability that the shuttle would explode, which will kill all the persons on the board.
- Postponing the launch will lead to loss of future contracts from NASA , the loss of job to many workers

Thus this problem of moral dilemma is due to problem of conflicting reasons

c. **The problem of disagreement:** There may be two or more solutions and none of them mandatory. These solutions may be better or worse in some respects but not in all aspects. One has to interpret, apply different morally reasons, and analyze and rank the decisions. Select the best suitable, under the existing and the most probable conditions.

Example : In most corporations, there are disagreements among managers regarding whether customers can be allowed to inspect their plants and procedures, as a confidence building measure

2.6.3.Steps to Solve Dilemma

The logical steps in confronting moral dilemma are:

a. Identification of the moral factors and reasons. The clarity to identify the relevant moral values from among duties, rights, goods and obligations is obtained conceptual inquiry). The most useful resource in identifying dilemmas in engineering is the professional codes of ethics, as interpreted by the professional experience. Another resource is talking with colleagues who can focus or narrow down the choice of values.

b. Collection of all information, data, and facts (factual inquiry) relevant to the situation.

c. Rank the moral options i.e., priority in application through value system, and also as obligatory, all right, acceptable, not acceptable, damaging, and most damaging etc. For example, in fulfilling responsibility, the codes give prime importance to public safety and protection of the environment, as compared to the individuals or the employers (conceptual inquiry).

d. Generate alternate courses of action to resolve the dilemma. Write down the main options and sub-options as a matrix or decision tree to ensure that all options are included.

e. Discuss with colleagues and obtain their perspectives, priorities, and suggestions on various alternatives.

f. Decide upon a final course of action, based on priority fixed or assumed. If there is no ideal solution, we arrive at a partially satisfactory or 'satisfying' solution.

2.7. Moral Autonomy

2.7.1.Definition

- Moral autonomy is defined as, decisions and actions exercised on the basis of moral concern for other people and recognition of good moral reasons.
- Alternatively, moral autonomy means 'self determinant or independent'. The autonomous people hold moral beliefs and attitudes based on their critical reflection rather than on passive adoption of the conventions of the society or profession.
- Moral autonomy may also be defined as a skill and habit of thinking rationally about the ethical issues, on the basis of moral concern.

- Viewing engineering as social experimentation will promote autonomous participation and retain one's professional identity.
- Periodical performance appraisals, tight-time schedules and fear of foreign competition threatens this autonomy.

- The attitude of the management should allow latitude in the judgments of their engineers on moral issues. If management views profitability is more important than consistent quality and retention of the customers that discourage the moral autonomy, engineers are compelled to seek the support from their professional societies and outside organizations for moral support.
- It appears that the blue-collar workers with the support of the union can adopt better autonomy than the employed professionals. Only recently the legal support has been obtained by the professional societies in exhibiting moral autonomy by professionals in this country as well as in the West.

2.7.2. Factors influencing Moral concern

a. Atmosphere in which person is brought up in his childhood
b. One's relationship with friends and relatives.
c. One's interaction with his neighbors.
d. One's family structure and the family's economy.
e. Influence of religious Institutions such as temples, churches, Mosques etc.
f. Influence of educational Institutions such as school, colleges etc
g. Influence of teachers and other mentors.
h. Influence of media like newspapers, novels, television, movies etc
i. Influence of some social events.

2.7.3. Skills needed to improve Moral Autonomy

The engineering skills related to moral autonomy are listed as follows:

- Proficiency in recognizing moral problems in engineering and ability to distinguish as well as relate them to problems in law, economics, and religion,
- Skill in comprehending, clarifying, and critically-assessing arguments on different aspects of moral issues,
- Ability to form consistent and comprehensive view points based on facts,
- Awareness of alternate responses to the issues and creative solutions for practical difficulties,
- Sensitivity to genuine difficulties and subtleties, including willingness to undergo and tolerate some uncertainty while making decisions,
- Using rational dialogue in resolving moral conflicts and developing tolerance of different perspectives among morally reasonable people, and
- Maintaining moral integrity.

2.8. Theories of Moral Development

2.8.1. Kohlberg's Theory

- ✓ Born on October 25, 1927 in Bronxville, New York
- ✓ Attended Andover Academy in Massachusetts, a private high school for bright and usually wealthy students
- ✓ Before college he was an engineer on an old freighter carrying refugees from parts of Europe to Israel
- ✓ Studied psychology at the University of Chicago
- ✓ First became a clinical psychologist before creating his own theory
- ✓ Spent many years researching how an individual develops their own moral codes

✓ There are three Stages of Moral Development

✓ **Pre-conventional Level**

- **It is** based on the desire to derive benefits for oneself
- In the first level, individuals behave according to socially acceptable norms, which are taught mainly by parents and teachers

- In this first level, individuals are motivated mainly by their interest to avoid punishment, or by their desire to satisfy their own needs or by external power exerted on them
- Whatever benefits oneself or avoids punishment. This is the level of development of all young children. -Avoid punishment & Gain Reward

✓ **Conventional Level**

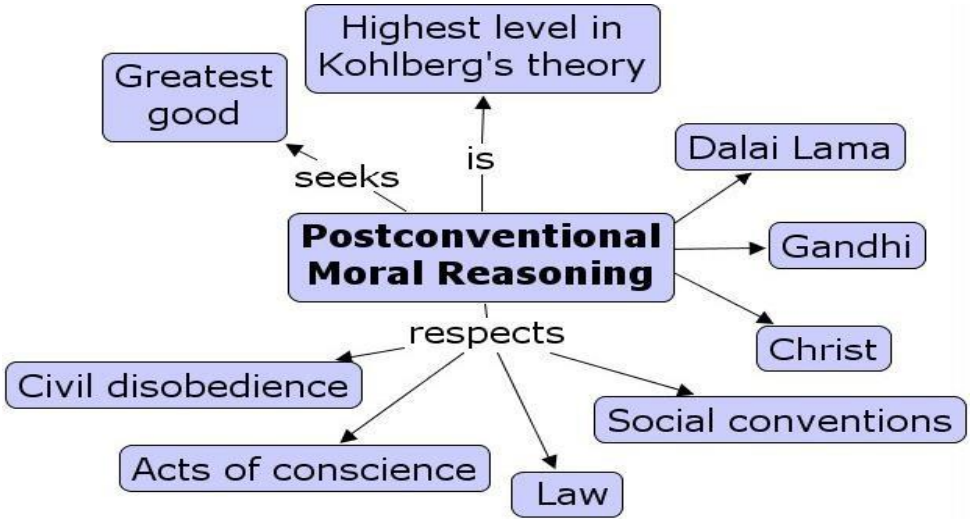
- In the second level, the moral thinking and behavior of the individual are determined by the standards of their family, community and society. Uncritical acceptance of one's family, group or society are accepted as final standard of morality.
- At this level, individuals are motivated by the desire to please others and to meet the social unit's expectations, without bothering much about their self interest.
- Here in the second level, individuals give more importance to loyalty and close identification with others than their own self interest
- Most adults do not mature beyond this stage.
    1. Gain Approval & Avoid Disapproval &
    2. Duty & Guilt

✓ **Post-conventional Level**

- Here in this level, the individuals are guided by strong principles and convictions, not by selfish needs or pressure from society
- These individuals are called as autonomous, because they think for/by themselves and also they do not believe that customs are always right
- The people of this level live by principles that can be accepted by all
- But majority of people do not reach this level
    1. Agreed upon rights &
    2. Personal moral standards

Kohlberg's level of Moral development

Level	Appropriate age range	Moral Development
Pre conventional	Birth to 9 years	✓ Self centered attitude ✓ Willingness to avoid punishment ✓ Desire to gain reward
Conventional	Ages 9 to 20 years	✓ Respect for conventional rules and authority ✓ Willingness to please or satisfy others ✓ Importance to loyalty and close identification with others
Post conventional	Over 20 years or may be never	✓ Thinking for and by themselves ✓ Agreed upon universal general principles ✓ Personal moral standards



- ✓ **Drawbacks of Kohlberg's theory**
  - How to judge, whether the individual belongs to first level, second level or third level?
  - **What are the criteria?**
  - What is the exact stage for moral development?
  - What is the stage of moral maturity?
  - **Only few people are in post conventional level. Hence it does recor majority followers**

2.8.2.Carol Gilligan Theory

- Carol Gilligan is a contemporary psychologist who has conducted extensive research into women's approach to moral problems.
- Carol Gilligan was born in New York City on November 28, 1936. She studied literature at Swarthmore College as an undergrad, and she graduated from Radcliffe in 1960 with a master's in psychology.
- She continued to Harvard, where she received her PhD in psychology in 1964. Three years later, Gilligan took a teaching position at Harvard where she worked alongside Erik Erikson and Lawrence Kohlberg.
- While Gilligan worked as a research assistant under Kohlberg, known for his theory of moral development, she began focusing on the moral dilemmas and development of young girls.
- Kohlberg's theory demonstrates that children progress through several stages of moral reasoning, though not everyone reaches the highest levels
- of moral reasoning, where justice and individual rights are guiding principles in a person's life. Kohlberg found that more men reached this stage of moral reasoning than women and that men tended to be heavily focused on justice.
- Gilligan criticized this theory, arguing that it was biased in favor of men. In her own research, Gilligan found that women placed a stronger emphasis on caring in moral decision making.
- **The three stages of Moral development**
- **Pre-conventional Level**
  - This is the same as Kohlberg's first level in that the person is preoccupied with self centered reasoning, caring for the needs and desires of self.
- **Conventional level**

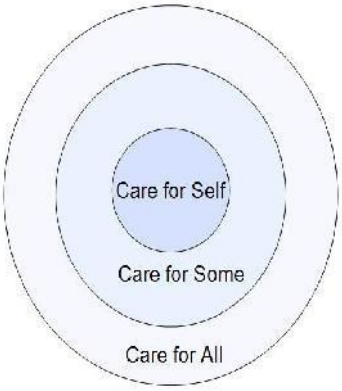
- ✓ Here the thinking is opposite in that, one is preoccupied with not hurting others and a willingness to sacrifice one's own interests in order to help or nurture others (or retain friendship).

- **Post-conventional Level**
  - Achieved through context-oriented reasoning, rather than by applying abstract rules ranked in a hierarchy of importance. Here the individual becomes able to strike a reasoned balance between caring about other people and pursuing **one's own self-interest while exercising one's rights.**

Gilligan's level of Moral development

Level	Appropriate age range	Moral Development
Pre conventional	Not listed	✓ Goals is individual survival. i.e., self centered attitude
✓ Transition is from selfishness to responsibility to others		
Conventional	Not listed	✓ Self sacrifice is goodness. i.e., individuals sacrifice their interest to others.
✓ Transition is fromm foodness to truth that she is a person too		
Post conventional	May be never	✓ Principle of Non violence – do not hurt others or self ✓ To balance between one's own needs with the needs of others

Note: **thus the Kohlberg gives greater emphasis to recognizing rights and abstract universal rules. Whereas, Gilligan stresses the importance of maintaining personal relationships based on mutual caring**



1. **Differences between the TWO THEORIES**

Kohlberg's Theory	*Carol Gilligan's Theory*
A. Basic Aspects	
1. Is based on the study on men. 2. Men give importance to moral rule. 3. Ethics of rules and rights.	1. Is based on the study on men and women 2. Women always want to keep up the personal relationships with all the persons involved in the situations. 3. Women give attention to circumstances leading to critical situations rather than rules: (context-oriented and ethics of care)
B Characteristic Features	

1. Justice	1. Reason
2. Factual	2. Emotional
3. Right or wrong	3. Impact on relationships
4. Logic only	4. Compassion too
5. Logic and rule-based	5. Caring and concern
6. Less of caring	6. More of caring
7. Matter of fact (practical)	7. Abstract
8. Present focus	8. Future focus
9. Strict rules	9. Making exceptions
10. Independence	10. Dependence
11. Rigid	11. Human-oriented
12. Taking a commanding role	12. Shying away from decision-making
13. Transactional approach	13. Transformational approach

- ✓ **Example :**
- ✓ **<u>The difference in these two theories is explained through the well-known example, Heinz's dilemma</u>**

2. Heinz being poor and a debtor could not buy the costly medicine for his sick wife, at ten times the normal cost. Initially he begged the Pharmacist to sell at half the price or allow him to pay for it later. Pharmacist refused to oblige him either way. Finally he forcibly entered the Pharmacy and stole the drug.
3. According to Kohlberg study, men observed that the theft was morally 'wrong' at the conventional level, because the property right was violated. But men at the post-conventional level, concluded that the theft was 'right', as the life of the human being was in danger. But women observed that Heinz was wrong. They observed that instead of stealing he could have tried other solutions (threatening or payment in installments?) to convince the Pharmacist.
4. Gilligan however attributed the decision by women as context-oriented and not on the basis of rules ranked in the order of priority.

2.9. Consensus and controversy

Consensus means "agreement " and controversy means disagreement

- ✓ When an individual exercise moral autonomy , he may not able to attain the same results as other people obtain in practicing their moral autonomy.

In exercising moral autonomy, one is not likely to obtain the same results as by others. This situation is likely to end in a controversy. In this case, good amount of tolerance among the individuals who are autonomous, reasonable and responsible is necessary. This does not mean forcing the engineers to reach unique moral solutions. Many reasonable solutions are possible to a given ethical problem. The ethics make the engineers realize the importance of tolerance among them, in case of disagreement while applying moral autonomy.

- ***Relationship between autonomy and authority***
  1. Moral autonomy and respect for authority are compatible with each other. Exercising moral autonomy is based on the moral concern for other people and recognition of good moral reasons. Also moral autonomy emphasizes the capabilities and responsibilities of people. Authority provides the framework through which learning attitudes are encouraged.
  2. Sometimes, conflicts will arise between individuals' need for autonomy and the need for consensus about authority. This situation can be reduced by having open and frank discussion regarding a moral issue with the help of authority.
- ***Illustration:*** Consider the relationship between autonomy and authority, with reference to a classroom. In the classroom, the teachers have authority over students. Authority of the teachers help in maintaining the dignity and decorum of academic climate in a institution; also in restoring the confidence and respect between teachers and students.

As per the first point, there should be the acceptance of authority by both the teachers and students, in order to conduct the classes in orderly ways.

When the authority is misused, conflicts may arise between autonomy and authority. As per the second point, allowing open discussions between teachers and students can reduce the unhealthy academic atmosphere.

2.10. Professions

2.10.1. What is Profession?

The Latin root of word "profession" means the making of a public declaration
Profession is defined as any occupation/job/vocation that requires advanced expertise (skills and knowledge), self regulation and concerted service to the public good. It brings a high status, socially and economically

<u>How do job and Occupation differ from profession</u>

- Ant work for hire can be considered as job , irrespective of skills level involved and the responsibility approved
- Occupation means employment through which someone makes a living
- Engineering is a job and also occupation. They are paid for services. They make living out of it. But skills and responsibilities involved in engineering is more than job
- The professions are occupations requiring sophisticated knowledge, group commitment to some public good, and significant degree of self Regulation

2.11. Characteristics of Profession

1. *Advanced expetise*: Many professions require sophisticated skills (do-how) and theoretical knowledge (know-how and why). Formal education, training, continuing education, updating are needed.
2. *Self regulation*: Professional societies play important role in setting standards for admission to profession, drafting codes of ethics, enforcing standards of conduct, and representing the profession before the public and the government.
3. *Public good*: The occupation provides some important public good, by concerted efforts to maintain ethical standards. For example, a physician promotes health, a lawyer protects the legal rights, an engineer provides a product or a project for use by the public towards their health, welfare, and safety. Teaching is also claimed as a profession as it helps shaping and training the minds of the students, young as well as old.

2.11.1. Who is Professional?

Some argue that jobs such as carpenter, barbers, porters, and drivers are to be recognized as professions. It is open for discussion. Such things can not be decided by referring to dictionary alone. A thorough analysis of the activities expected of these jobs is to be made and checked with explanation of the requirements of a profession before deciding it as profession. For example, having been engaged for driving one's vehicle is not a profession. But an ace driver who is engaged by a travel agency to drive different types of cars for tourists extends courtesy to the customers, requires education, expertise (a valid driving license), and respect to the public. His job may be termed as a profession. A mercenary is not a professional as he acts against public good

PROFESSIONAL relates to a person or any work that a person does on profession, and which requires expertise (skills and knowledge), self-regulation and results in public good. The term professional means a 'person' as well as a 'status'.

PROFESSIONALISM: It is the status of a professional which implies certain attitudes or typical qualities that are expected of a professional. According to **Macintyre**, professionalism is defines as the *services related to achieving the public good, in addition to the practices of the knowledge of moral ideals.*

The criteria for achieving and sustaining professional status or professionalism are:

- **Advanced expertise**: The expertise includes sophisticated skills and theoretical knowledge in exercising judgment. This means a professional should analyse the problem in specific known area, in an objective manner.
- **Self-regulation**: One should analyse the problem independent of self-interest and direct to a decision towards the best interest of the clients/customers. An autonomous judgment (unbiased and on merits only) is expected. In such situations, the codes of conduct of professional societies are followed as guidance.
- **Public good**: One should not be a mere paid employee of an individual or a teaching college or manufacturing organization, to execute whatever the employer wants one to do. The job should be recognised by the public. The concerted efforts in the job should be towards promotion of the welfare, safety, and health of the public.

2.11.2. Characteristics

The characteristics of the 'profession' as distinct from 'non-professional occupation' are listed as follows:

- **Extensive Training:** Entry into the profession requires an extensive period of training of intellectual (competence) and moral (integrity) character. The theoretical base is obtained through formal education, usually in an academic institution. It may be a Bachelor degree from a college or university or an advanced degree conferred by professional schools.
- **Knowledge and Skills**: Knowledge and skills (competence) are necessary for the well-being of the society. Knowledge of physicians protects us from disease and restores health. The lawyer's knowledge is useful when we are sued of a crime, or if our business is to be merged or closed or when we buy a property. The Chartered Accountant's knowledge is important for the success of recording financial transactions or when we file the income return. The knowledge, study, and research of the engineers are required for the safety of the air plane, for the technological advances and for national defense.
- **Monopoly: The monopoly control is achieved in two ways:**
  - the profession convinces the community that only those who have graduated from the professional school should be allowed to hold the professional title. The profession also gains control over professional schools by establishing accreditation standards
  - By persuading the community to have a licensing system for those who want to enter the profession. If practicing without license, they are liable to pay penalties.
- **Autonomy in Workplace**: Professionals engaged in private practice have considerable freedom in choosing their clients or patients. Even the professionals working in large organizations exercise a large degree of impartiality, creativity and discretion (care with decision and communication) in carrying their responsibilities. Besides this, professionals are empowered with certain rights to establish their autonomy.
  - Accordingly physicians must determine the most appropriate medical treatments for their patients and lawyers must decide on the most successful defense for their clients. The possession of specialized knowledge is thus a powerful defense of professional autonomy.
- **Ethical Standards**: Professional societies promulgate the codes of conduct to regulate the professionals against their abuse or any unethical decisions and actions (impartiality, responsibility) affecting the individuals or groups or the society.

2.11.3. Models Of Professional Roles

- Promotion of public good is the primary concern of the professional engineers. There are several role models to whom the engineers are attracted. These models provoke their thinking, attitudes and actions.
- **Savior:** The engineer as a savior, save the society from poverty, illiteracy, wastage, inefficiency, ill health, human (labor) dignity and lead it to prosperity, through technological development and social planning. For example, R.L. Stevenson.
- **Guardian:** He guards the interests of the poor and general public. As one who is conversant with technology development, is given the authority befitting his expertise to determine what is best suited to the society. For example, Lawrence of Arabia (an engineer).

- **Bureaucratic Servant**: He serves the organization and the employers. The management of an enterprise fixes its goals and assigns the job of problem solving to the engineer, who accepts the challenge and shapes them into concrete achievements. For example, Jamshedji Tata.
- **Social Servant**: It is one who exhibits social responsibility. The engineer translates the interest and aspirations of the society into a reality, remembering that his true master is the society at large. For example, Sir M.Viswesvarayya.
- **Social Enabler and Catalyst:** One who changes the society through technology. The engineer must assist the management and the society to understand their needs and make informed decisions on the desirable technological development and minimize the negative effects of technology on people and their living environment. Thus, he shines as a social enabler and a catalyst for further growth. For example, Sri Sundarlal Bahuguna.
- **Game Player:** He is neither a servant nor master. An engineer is an assertive player, not a passive player who may carry out his master's voice. He plays a unique role successfully within the organization, enjoying the excitement of the profession and having the satisfaction of surging ahead in a competitive world. For example, Narayanamurthy, Infosys and Dr. Kasthurirangan, ISRO.

2.12. Professional Responsibility

2.12.1. Senses

There are different senses of responsibility, such as:

- **Characteristic Quality -** Primarily responsibility implies duty with care and efforts.
- **Obligations -** These are one's moral responsibility i.e., duty to act right and in moral ways. The obligations such as honesty, fairness, and decency are incumbent on every one. In addition to this, we have role responsibilities assigned by taking up various roles, such as parents, inspectors, and employees. For example, a Safety Engineer has a responsibility to make regular inspections in a factory shops.
- **General Moral Capacity -** One has the general capacity for moral agency, including the understanding and action on moral reasons.
- **Liability and Accountability -** Liability and Accountability for actions. It means that one is liable (with a legal sense) to meet the obligations in better ways. The person is likely to respond legally, if necessary. Accountable means that one is willing to justify or defend the decisions, actions or means and outcomes. It could include offering a reasonable excuse or accepting the shame for not having met the end results or accepting the guilt for harming others. One is also answerable to the assessment by others on one's actions (means) or outcomes.
- **Praiseworthiness/Blameworthiness:** When accountability for wrong actions or results is at issue, responsibility means blameworthy. When the right conduct or successful result is at issue, responsible is synonymous with praiseworthy.

2.12.2. Types of Responsibility

Different types of responsibilities exhibited in human transactions are:

- **Moral Responsibility:**

  Moral responsibility as applied to a professional: A professional must be responsible morally, in creating internal good or good outcomes, and eliminating /minimizing un-intended side-effects, from engineering and technology. It includes:

- ✓ **Obligations:** A commitment to moral actions (primary obligation to protect the safety of the human beings and respect their rights),
- ✓ **Conscientious:** A comprehensive perspective to accept the duties, and diligently do the right things by putting their heart, head and hands (awareness of the experimental nature of the product/project, anticipating possible and unexpected outcomes and putting efforts to monitor them),
- ✓ **Accountability** (being accountable for the decisions, actions, and the results of product/ project including safety), and
- ✓ **Praiseworthy/Blameworthy** as applied to context of doing things right/doing things wrongly, respectively.

- **Causal Responsibility**

It is being a cause of some event. For example, a child playing with matches cause a house to burn. The child is causally responsible, but the parent who left the child with matches, is morally responsible.

- **Job Responsibility -** It consists of assigned tasks at the place of employment and achieving the objectives.
- **Legal Responsibility** - It is the response required by law and includes legal obligations and accountability to meet them.Many of these responsibilities overlap with moral responsibility.

2.12.3. Responsible Professionalism

- The most comprehensive virtue of engineers is responsible professionalism. It can also be called Professional Responsibility. This consists of five types of virtues, as follows:
- **Self-direction (Self-governance) virtues** are fundamental and necessary in exercising moral responsibility. On the basis of 'understanding and cognition', it includes self-understanding, humility (proper assessment of one's character), and good moral judgment (termed as 'practical wisdom' by Aristotle). On the basis of 'commitment and action', it covers courage, self discipline, perseverance, self-respect, and integrity. Honesty a virtue common to both bases as it implies truthfulness in thoughts and words and trustworthiness in actions.
- **Public-spirited virtues** focus on the good of the clients and the public. It includes the respect for rights (to make decisions and face the risk), non-malfeasance (not harming others intentionally). Engineering codes go a step further and prescribe beneficence that includes preventing or removing harm to others and also promoting the public safety, health, and welfare, generosity (helping the community by voluntarily giving their time, talent, and money-voluntary service to the professional society and community), and justice (unbiased) in all decisions and actions.
- **Team-work virtues** enable the professionals to work successfully with others. They include collegiality, cooperativeness, communicative ability, and respect for legitimate authority. Responsible exercise of authority and the ability to motivate other to achieve are also the relevant to team-work virtues.
- **Proficiency virtues**, which mean the mastery of technical skills (called as Intellectual Virtue by Aristotle). It includes competence (having qualified, licensed, and prepared to execute the job that is undertaken), diligence (alert to dangers, careful attention, and avoidance of laziness or workaholic nature), creativity (learning to respond to the changing technological society), excellence (perform at the highest level), and self-renewal through continuing education.

- **Cardinal (chief) virtues**: Wisdom (prudence), courage (fortitude), temperance and justice. Some of these may overlap other virtues. They are called 'cardinal' (Latin: cardo, hinge) because they are hinges on which all virtues depend. These are also called moral (Latin: mores, fixed values) because they govern our actions, regulate our passions, and guide our conduct according to faith and reason. Wisdom is perception of truth and ability to distinguish between the right and wrong. Courage means a firm and elevated mind. Temperance represents order in words and actions. Justice is preserving humanity and observing the faith of contracts. Although these virtues ring religious tones, they are very relevant to the engineering practice.

2.12.4. Social Responsibility

- Corporate organizations have social responsibility to all of their 'stakeholders'. This includes the wellbeing of the employees and their unions, socially responsible investors, customers, dealers, suppliers, local communities, governments, non-governmental organizations, and the business owners and managers. Besides showing concern with employee relations and other internal organizational matters, the organization is concerned with
  - how the product/project is marketed, used or misused, how it fails, and how it is disposed or discarded. The ways in which the used battery cells and computers are discarded have been debated in the engineers' forums.
  - protecting the work environment during manufacture as well as the external environment during transport or use
  - training the disadvantaged or physically-challenged workers
  - subcontracting and hiring practices, and
  - contribution to local communities to enrich their cultural, social, and civic life. It may be
  - even compensatory against the harm to environment (e.g., planting trees).

Various types of responsibilities such as causal, moral, and legal are distinguished through appropriate examples, as shown below:

Events	Responsibility
A stray cattle on the rail track caused the derailment of goods train	(a) Although cattle is the cause, the owner of the cattle is morally responsible (b) For letting the cattle go astray on the railway track, that is trespassing the owner is legally responsible
A child playing with (safety?) matches causes fire	Although the child is the cause, the parents who who have left the match box within the reach of the child, are morally responsible
(a) Seth was driving a car. He failed to stop at the red signal, which caused an accident (b) Suppose he applied brakes, but they failed	(a) Seth is causally responsible (b) Seth has been negligent of maintenance of brakes
There was a forest fire. It was traced to camp fire at specific site and Raj was the last to use the campsite.	Raj is causally responsible for the forest fire he failed to put out the camp fire. Although the temperature was high, and the dry leaves helped the fire to spread,

	Raj allowed the fire to spread. Hence, he is the cause
The products sold have caused harm while being used	The engineer or the engineering firm is legally responsible for the harmful effects of defects in their products. But they are not morally responsible for the harm or defects
A fitter lost one his eyes while inserting a chip by using a hammer	The hammer manufacturer was legally responsible on the basis of the doctrine of strict liability, which does not require any proof of effect in the design of the hammer. Morally the manufacturer was not responsible
In a contract, it is not implied that the engineer to be held for not observing the possibility of danger. But an accident occurs	The engineer is free from legal responsibility, but he has moral responsibility to observe the work done
A pandal erected by the contractor, in a marriage hall catches fire, due to a leakage of electric current	No legal responsibility for pandal contractor. Owner of the hall is morally responsible for the leakage
Question papers were leaked out by some persons, during transport	Controller of Examinations can not be held legally responsible, although he is morally responsible

2.12.5. Accountability

Accountability means:

- The capacity to understand and act on moral reasons
- **Willingness to** submit one's actions to moral scrutiny and be responsive to the assessment of others. It includes being answerable for meeting specific obligations, i.e., liable to justify (or give reasonable excuses) the decisions, actions or means, and outcomes (sometimes unexpected), when required by the stakeholders or by law.
- **Conscientiousness**: It means:
  - Being sensitive to full range of moral values and responsibilities and
  - The willingness to upgrade their skills, put efforts, and reach the best balance possible among those considerations, and
- **Blameworthy/Praiseworthy**: Own the responsibility for the good or wrong outcomes. Courage to accept the mistakes will ensure success in the efforts in future.
- The terms 'corporate responsibility' and 'corporate accountability' have different meanings. Corporate responsibility emphasizes the voluntary compliance of a particular organization to particular codes of conduct. The groups of individuals in the organization are assigned responsibilities through policy manuals and flow charts. The corporate accountability means holding all the corporate organizations accountable to the public, employees, customers, and stock holders, as empowered by rules and laws.

2.12.6. Obligation

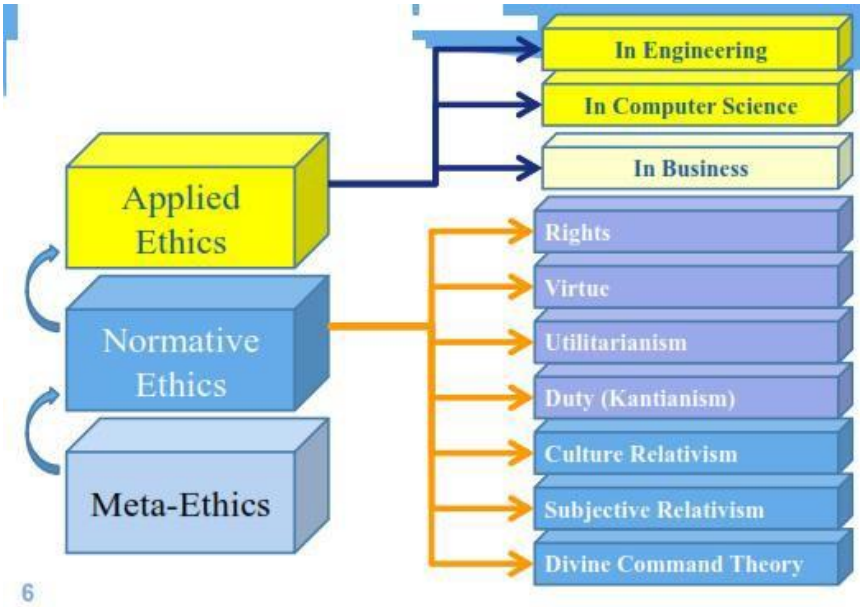
- **The safety and other obligations of professional engineers are justifiable based on the following aspects.**

- Moral obligations through laws and enforced codes of conduct
- Through membership of professional society
- Contractual agreement with the employers
- By entry into career as engineer upon graduation from Engineering institutions and
- By special employment agreements or agreement with professional societies.
- The paramount obligation means, giving importance to the safety, health, and welfare of the public in performing the professional duties.
- **Case Study: Choice of the Theory**
- The choice of the ethical theory to study a problem is illustrated herein with an example. In tackling ethical problems, we can apply all the theories and analyze the actions and results from different angles and see what result each theory gives rise to. This enables us to examine the problem in different perspectives. Many a time, the result will be the same though we have applied various theories.
- A chemical plant near a small town is discharging hazardous wastes into the fields nearby. The ground water gets contaminated and significant health problems surface in the community.
- Since harm is caused to the residents, the action is unethical as per rights ethics. The agriculturists who have the agrarian right of water supply have been over looked. The pollutants may endanger their profession and welfare. Hence, rights ethics also concludes that the action is unethical.
- The effects of polluted water and the cost to purify the water by the municipality may out weigh the economic benefits of the plant. Hence, the utilitarian analysis leads to the same conclusion.
- The groundwater harms the people and caused health problems. Hence, discharging the pollutants is unethical as per duty ethics.
- Generally, because the rights of the individuals should weigh strongly than the needs of the society as a whole, rights and duty ethics take precedence over utilitarian considerations.
- Caution is necessary in applying theory of virtue ethics. When we use the word ‘honor’, we mean it to be a measure of dignity and integrity. It is a positive virtue. When it points to ‘pride’ it is not a virtue and has a negative connotation. History abounds with examples of war, which have been fought and atrocities were committed on innocent people in order to preserve the honor (pride) of an individual or a nation. In using virtue ethics, we have to ensure that the traits of virtue are actually virtuous and will not lead to negative consequences.

2.13. Theories of Ethics

2.13.1. Types of Ethical Theories

S.NO	TYPES	BASED ON
1	Virtue ethics	Virtues and vices
2	Utilitarianism	Most good for most people
3	Duty ethics	Duties to respect persons
4	Rights ethics	Human Rights



2.13.2. Virtue Ethics Theory

Virtue	Too much	Too less
(Golden mean between extremes)		
Courage	Foolhardiness	Cowardice
Truthfulness	Revealing all in violation of tact and confidentiality	Being secretive or lacking in candor
Generosity	Wasting one's resources	Being miserly
Friendliness	Being annoyingly effusive	Sulky or surly

- **Virtue is often defined as moral distinction and goodness. A virtuous person exhibits good and beneficial qualities. In virtue ethics, actions are considered right if they support good character traits (virtues) and wrong if they support bad character traits (vices)**
- **Virtue ethics focuses on words such as responsibility, honesty, competence, and loyalty, which are virtues. Other virtues might include trustworthiness, fairness, caring, citizenship, and respect. Vices could include dishonesty, disloyalty, irresponsibility, or incompetence**.
- **Virtue ethics is closely tied to personal character**.
- In many ways, this theory may seem to be mostly personal ethics and not particularly applicable to engineering or professional ethics. However, personal morality cannot, or at any rate should not, be separated from professional morality. If a behavior is virtuous in the individual's personal life, the behavior is virtuous in his or her professional life as well.
- Virtues are desirable ways of relating to other individuals, groups and organizations. They are very much related to the motives, attitudes and emotions that are responsible for right or wrong conduct of an individual.
- Professionalism is mainly based on the virtue rather than the technological development, knowledge, economy etc

Do Engineers need Virtues?

- According to a professional code of Ethics, the professional responsibilities include virtues that go beyond fulfilling the basic duties of their professions.

Virtue	*Excess*	*Golden mean*	*Deficient*
Truthfulness (governs communication)	Revealing all in violation of tact and confidentiality	Necessary and sufficient, to proper person	Secretive
Courage (face danger, risk)	Roguishness, bold	Firm and humble	Cowardice
Generosity (giving)	Wasting resources	Give, in appropri-ate measure	Miserly
Friendliness (governs relationship)	Without anger, effusive	Within decent limits	Bad-tempered
Green environment	Exploitation	Protection	Neglect
Work and earn	Tiresome work (strained)	Balance of work and leisure	Lazy (no work) and more pay

Theories about Virtues

- The virtue ethics is about determining what kind of people should be
- In virtue ethics, one's actions are considered right if he holds good character virtues and wrong if we hold bad character vices. Thus virtue ethics is closely related to personal character.
- The two basics old good theories about virtues are:
  - Aristotle's theory of the Golden Mean and
  - Macintyre's theory of virtue

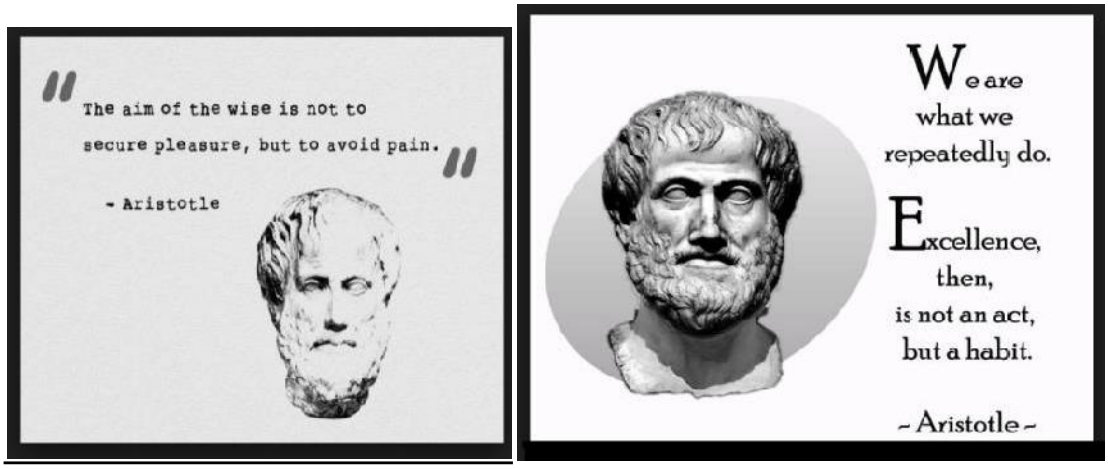
a. <u>Aristotle's theory of the Golden Mean</u>

- **The concept of Aristotle's theory of golden mean is represented in his work called "Nicomachean Ethics", in which Aristotle explains the origin, nature and development of virtues which are essential for achieving the ultimate goal, happiness (Greek: eudaimonia), which must be desired for itself.**
- The virtue or excellence of a thing causes that thing both to be itself in good condition and to perform its function well. Virtue, then, is a kind of moderation as it aims at the mean or moderate amount.
- Aristotle's ethics is strongly teleological, practical, which means that it should be the action that leads to the realization of the good of the human being as well as the whole.

- According to his theory, the virtue of wisdom or good judgment is highly essential for accomplishing the rational activities successfully
- **Virtues or tendencies to find the Golden Mean between the extremes of excess and deficiency**
- **In "The virtue of Aristotle's ethics ", Gottlieb (1) identifies the three core aspects of the doctrine of the mean. First, virtue, like health, is produced and preserved by avoiding extremes. Second, virtue is a mean relative to us. Third, each virtue is a mean between two vices, one of excess and one of deficiency.**
- The golden mean represents a balance between extremes or vices. For example, courage is the middle between one extreme of deficiency (cowardness) and the other extreme of excess (recklessness).
- The mean as concerns fear and confidence is courage: those that exceed in fearlessness are foolhardy, while those who exceed in fear are cowardly.
- The mean in respect to certain pleasures and pains is called temperance, while the excess is called profligacy. Deficiency in this matter is never found, so this sort of person does not have a name.
- In the matter of giving and earning money, the mean is liberality, excess and deficiency are prodigality and miserliness. But both vices exceed and fall short in giving and earning in contrary ways: the prodigal exceeds in spending, but falls short in earning; the miser exceeds in earning, but falls short in spending.
- With respect to honor and disgrace, the mean is "high-mindedness," the excess might be called vanity, and the deficiency might be called humility or small-mindedness.

Aristotle's Concept of the Golden Mean

Deficiency (−)	BALANCE	Excess (+)
cowardice	COURAGE	rashness
stinginess/miserliness	GENEROSITY	extravagance
sloth	AMBITION	greed
humility	MODESTY	pride
secrecy	HONESTY	loquacity
moroseness	GOOD HUMOR	absurdity
quarrelsomeness	FRIENDSHIP	flattery
self-indulgence	TEMPERANCE	insensibility
apathy	COMPOSURE	irritability
indecisiveness	SELF CONTROL	impulsiveness



b. Macintyre's Theory of Virtues

- **Alasdair Macintyre, a contemporary ethicist, related virtues with the social practices.** That is cooperative activities that are aimed at achieving public goods. These public goods should not be related to external goods such as money and prestige
- **According to Macintyre, any profession should develop for the sake of public goods. He calls the public goods as internal goods.**
- (MacIntyre 1981) Action-based theories neglect the communal context. He argues that the Enlightenment elevated autonomy (self-rule) which ends in individualism.
- Morality is rooted in practices, traditions and forms of life: a moral tradition which provides a narrative structure.
- Out of primary loyalty to family, friends and community proper virtues flow.
- Moral psychology is important: a theory of how we learn and how we are motivated to be good.
- **Examples**
  - **Good of medicine is the promotion of health**
  - **Good of law is social Justice**
  - **Good of Engineering is the safety, health and welfare of the Public**
  - **Good of Teaching is learning and self development**
- **Thus this theory defines professionalism as the services required for accomplishing the public goods, in addition to practice of advanced theoretical and practical Knowledge**

Strengths of Virtue Ethics

- It provides a motivation for good behaviors.
  - Utilitarianism and Kantianism's reasons behind the action is cold and analytical;
  - Virtue ethics stresses the importance of loyalty, thoughtfulness, courteousness of health social interactions
- It provides a solution to the problem of impartiality
  - Utilitarianism and Kantianism require being completely impartial and treating all human beings as equals.
  - Virtue ethics justifies you to take your children to Disneyland, instead of donating the money to starving children in Africa.

Weakness of Virtue Ethics

- The multiple virtues can allow the justification of injustices.

- One cannot apply virtue ethics alone in many cases.
- One has to set different priorities to different virtues in different situations.
- Example: You have limited resource to fight one of the two fires
    - Prudence: Fight the fire that can cause more property damage (Utilitarianism)
    - Fight the fire in the area that paid the city tax (Duty)

2.14. Theories of Right Action

2.14.1. Theory of Utilitarianism

- **Utilitarianism says the sole standard of right action is good consequences**. There is only one general moral requirement: Produce the most good for the most people, giving equal consideration to everyone affected.
- **The word *utility* is sometimes used to refer to good consequences and other times to the balance of good over bad consequences.**
- **The** utilitarian standard seems simple and reasonable. Surely morality involves producing good consequences— especially in engineering. Indeed, utilitarian modes of thinking are reflected in cost-benefit analyses
- Utilitarianism also seems a straight-forward way to interpret the central principle in most engineering codes: "**Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties**."
- *Welfare* is a rough synonym for *overall good* (utility), and safety and health might be viewed as especially important aspects of that good.
- *We can* measure *good* consequences by what **is *intrinsic good***—that is, good considered just by itself. All other good things **are *instrumental goods*** in that they provide means (instruments) for gaining intrinsic goods. Some utilitarian's consider pleasure to be the only intrinsic good. But that seems counterintuitive—there is nothing good about the pleasures of tyrants and sadists take in inflicting suffering.
- John Stuart Mill believed that happiness was the only intrinsic good, and hence he understood utilitarianism as the requirement to produce the greatest amount of happiness.
- Sometimes Mill confused happiness with pleasures and enjoyments, which are short-term, feel-good states of consciousness.
- Mill thought of happiness as (a) a life rich in pleasures, especially the "higher" pleasures of friendship, love, and intellectual endeavors, mixed with some inevitable pains, plus (b) a pattern of activities and relationships that we can affirm as the way we want our lives to be.
- Some utilitarian's understand intrinsic goods as those which a reasonable person would pursue, or those which satisfy rational desires—those that we can affirm after fully examining them in light of relevant information, for example, love, friendship, appreciation of beauty, in addition to happiness.
- Most economists adopt a preference theory: What is good is what individuals prefer, as manifested in what they choose to purchase in the marketplace.
- In addition to developing a reasonable view of intrinsic good, we need to decide whether to focus on individual actions or general rules.
- **Act Utilitarianism**
    - Classical, nineteenth-century utilitarian's such as Mill believed in ***act-utilitarianism a*** particular action is right if it is likely to produce the most good for the most people in a given situation, compared with alternative options available. The standard can be applied at any moment. Each option would have both immediate and long-term

consequences that can be estimated. The right action is the one that produces the most overall good, taking into account everyone affected.

- **Act-utilitarianism seems vulnerable to objections**. It apparently permits some actions that we know, on other grounds, are patently immoral. Suppose that stealing a computer from my employer, an old one scheduled for replacement anyway, benefits me significantly and causes only miniscule harm to the employer and others. We know that the theft is unethical, and hence act-utilitarianism seems to justify wrongdoing. Again, suppose that in a particular situation more good is promoted by keeping the public ignorant about serious dangers, for example, by not informing them about a hidden fault in a car or building. Or suppose that it will improve company morale if several disliked engineers are fired after being blamed for mistakes they did not make. Doing so is unfair, but the overall good is promoted.

- **Rule Utilitarianism**
  - An alternative version of utilitarianism that says we should maximize the good through following rules that maximize good consequences, rather than through isolated actions.
  - **According to this view, called *rule-utilitarianism*, right actions are those required by rules that produce the most good for the most people.**
  - Because rules interact with each other, we need to consider a set of rules. Thus, we should seek to discover and act on an *optimal moral code*—that set of rules which maximizes the public good more than alternative codes would (or at least as much as alternatives).
  - Rule-utilitarian's have in mind society-wide rules, but the same idea applies to rules stated in engineering codes of ethics. Thus, an engineering code of ethics is justified in terms of its overall good consequences , and so engineers should abide by it even when an exception might happen to be beneficial.

2.15. Theory of Duty Ethics

- Rights and duties are typically correlated with each other. For example, our right to life places duties on others not to kill us, and our right to liberty places duties on others not to interfere with our freedom. *Duty ethics* reverses the order of priority by beginning with duties and deriving rights from them. Although the similarities between duty ethics and rights ethics are pronounced, historically they developed as distinct moral traditions.
- Duty ethics says that right actions are those required by duties to respect the liberty or autonomy (self-determination) of individuals. One duty ethicist suggests the following list of important duties: "(1) Do not kill. (2) Do not cause pain. (3) Do not disable.

2.15.1. Kant's theory of Duty Ethics

- The duty ethics theory, proposed by Immanuel Kant (1724-1804) states, that actions are consequences of performance of one's duties such as, 'being honest', 'not cause suffering of others', 'being fair to others including the meek and week', 'being grateful', 'keeping promises' etc. The stress is on the universal principle of respect for autonomy i.e., respect and rationality of persons.
- As per Kant we have duties to ourselves, as we are rational and autonomous beings. We ought always to treat persons as having their own rational aims, and not merely use them for our ends. Immorality occurs when we reduce other people to mere means to our ends and needs. Violent acts such as murder, rape, and torture are obvious ways of treating people as mere objects serving our own purposes. We also fail to respect persons if we fail to provide support for them when they are in desperate need, and we can help them at little inconvenience to ourselves. Some duties, then, are to refrain from interfering with a person's liberty, and some express

requirements to help them when they are in need, thereby paralleling the distinction between liberty and positive rights

- We have a duty not to commit suicide; a duty to develop our talents and a duty to avoid harmful drugs. Kant insisted that moral duties are categorical necessary. They are commands that we impose on ourselves as well as other rational beings. A businessperson who is honest solely because honesty pays—in terms of profits from customers who return and recommend their services, as well as from avoiding jail for dishonesty—fails to fully meet the requirements of morality. In this way, morality involves attention to motives and intentions, an idea also important in virtue ethics.

2.15.2. John Rawls's modern Theory of Duty Ethics

- **On the other hand, the DUTY ethics theory, as enunciated by John Rawl**, gave importance to the actions that would be voluntarily agreed upon by all persons concerned, assuming impartiality. His view emphasized the autonomy each person exercises in forming agreements with other rational people.
- Rawl proposed two basic moral principles; (1) each person is entitled to the most extensive amount of liberty compatible with an equal amount for others, and (2) differences in social power and economic benefits are justified only when they are likely to benefit everyone, including members of the most disadvantaged groups.
- The first principle is of prime importance and should be satisfied first. Without basic liberties other economic or social benefits cannot be sustained for long.
- The second principle insists that to allow some people with great wealth and power is justified only when all other groups are benefited.
- In the business scenario, for example, the free enterprise is permissible so far it provides the capital needed to invest and prosper, thereby making job opportunities to the public and taxes to fund the government spending on the welfare schemes on the poor people.
- **C.W.D. Ross, the British philosopher introduced the term prima facie duties, which means duties might have justified exceptions.**
- In fact, most duties are prima facie ones; some may have obligatory or permissible exceptions. Ross assumed that the prima facie duties are intuitively obvious (self-evident), while fixing priorities among duties. He noted that the principles such as 'Do not kill' and 'protect innocent life' involve high respect for persons than other principles such as, 'Do not lie' (less harmful).
- **He has listed various aspects of Duty Ethics that reflect our moral convictions, namely:**
  - Fidelity : duty to keep promises.
  - Reparation : duty to compensate others when we harm them.
  - Gratitude : duty to thank those who help us.
  - Justice : duty to recognize merit.
  - Beneficence : duty to recognize inequality and improve the condition of others.
  - Self-improvement: duty to improve virtue and intelligence.

  Non-malfeasance: duty not to injure others.

2.16. Theory of Right Ethics

- **The ethical theory called *rights ethics* is distinctive in that it makes human rights the ultimate appeal**. Human rights constitute a moral authority to make legitimate moral demands on others to respect our choices, recognizing that others can make similar claims on us.

- The rights ethics emphasizes respecting the inherent dignity and worth of individuals as they exercise their liberty. Rights ethics is the most familiar ethical theory, for it provides the moral foundation of the political and legal system of the United States.
- Thus, in the *Declaration of Independence* Thomas Jefferson wrote: "**We hold these truths to be self-evident; that all men are created equal; that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness**."
- Unalienable—or inalienable, natural, human—rights cannot be taken away (alienated) from us, although of course they are sometimes violated. Human rights have been appealed to in all the major social movements of the twentieth century, including the women's movement, the civil rights movement, the farm workers' movement, the gay rights movement, and the patients' rights movement (in health care).
- The idea of human rights is the single most powerful moral concept in making cross-cultural moral judgments about customs and laws. As such, the notions of human rights and legal rights are distinct. Legal rights are simply those the law of a given society says one has, whereas human rights are those we have as humans, whether the law recognizes them or not.

- Rights ethics applies to engineering in many ways. It provides a powerful foundation for the special ethical requirements in engineering and other professions. Most engineering codes of ethics enjoin holding paramount the safety, health, and welfare of the public, a requirement that can be interpreted as having respect for the public's rights to life, rights not to be injured by dangerous products, rights to privacy, and rights to receive benefits through fair and honest exchanges in a free marketplace.
- In addition to human rights, there are *special moral rights*— rights held by particular individuals rather than by every human being. For example, engineers and their employers have special moral rights that arise from their respective roles and the contracts they make with each other. Special rights are grounded in human rights, however indirectly.
- Rights ethics are of two kinds they are liberty rights and welfare rights. ***Liberty rights (negative rights)*** are rights to exercise our liberty, and they place duties on other people not to interfere with our freedom. ***Welfare rights*** are rights to benefits needed for a decent human life, when we cannot earn those benefits, perhaps because we are severely handicapped, and when the community has them available. (They are sometimes called positive rights.)
- Another influential version of rights ethics, however, denies there are welfare human rights. *Libertarians* believe that only liberty rights exist; there are no welfare rights.

a. Locke's version of right ethics

- John Locke (1632–1704), who was the first philosopher to carefully articulate a rights ethics, is often interpreted as a libertarian. Locke's version of human rights ethics was highly individualistic. He viewed rights primarily as entitlements that prevent other people from meddling in our lives. The individualistic aspect of Locke's thought is reflected in the contemporary political scene in the Libertarian political party and outlook, with its emphases on protecting private property, dismantling welfare systems, and opposition to extensive government regulation of business and the professions.
- Libertarians take a harsh view of taxes and government involvement beyond the bare minimum necessary for national defense, a legal system, and the preservation of free enterprise.
- Locke thought of property as whatever we gained by "mixing our labor" with things—for example, coming to own lumber by going into the wilderness and cutting down a tree. Even so,

Locke's followers tended to insist that property was sacrosanct and that governments continually intruded on property rights, particularly in the form of excessive taxation and regulation.

b. Melden's version of right theory

- As per A.I. Melden's theory based on rights, nature mandates that we should not harm others' life, health, liberty or property. Melden allowed welfare rights also for living a decent human life. He highlighted that the rights should be based on the social welfare system.

c. Human rights:

- Human rights are explained in two forms, namely liberty rights and welfare rights. Liberty rights are rights to exercise one's liberty and stresses duties on other people not to interfere with one's freedom. The four features of liberty rights (also called moral rights), which lay the base for Government Administration, are:
    1. Rights are natural in so far as they are not invented or created by government.
    2. They are universal, as they do not change from country to country.
    3. They are equal since the rights are the same for all people, irrespective of caste, race, creed or sex.
    4. They are inalienable i.e., one cannot hand over his rights to another person such as selling oneself to slavery.
- The Welfare Rights are the rights to benefit the needy for a decent human life, when one cannot earn those benefits and when those benefits are available in the society.

d. Economic rights:

- In the free-market economy, the very purpose of the existence of the manufacturer, the sellers and the service providers is to serve the consumer. The consumer is eligible to exercise some rights. . The consumers' six basic rights are: Right to Information, Right to Safety, Right to Choice, Right to be Heard, Right to Redressal, and Right to Consumer Education.
- A few rights are absolute, i.e., unlimited and have no justifiable exceptions. For example, rights ethicists view that the rights have not been violated if the people purchase a (technological product) hang glider and they get injured by flying them carelessly or under bad weather conditions. But human rights imply that one not to be poisoned or killed by technological products, whose dangers are not obvious or wantonly hidden. They imply a right to be informed, when the purchase was made, of the possible dangers during use or service (obtaining informed consent).

  Rights ethics is distinctive in that it makes human rights the ultimate appeal — the moral bottom line. Human rights constitute a moral authority to make legitimate moral demands on others to respect our choices, recognizing that others can make similar claims on us. Thus, we see that the rights ethics provides a powerful foundation for the special ethical requirements in engineering and other professions.

2.17. Interconnectedness among virtues

2.17.1. Integrity

- Moral Integrity is the unity of character based on the moral concern and honesty
- Integrity is a bridge that links the responsibilities between one's personal life and professional life
- According to the principle of unity, there should be perfect morality both in personal life and professional life
- The virtues of self respect and pride in one's work are possible only through the virtue of integrity

- Maintaining integrity often requires the value of compromise. Compromises are sometimes good and sometimes bad. Therefore, in order to maintain moral integrity, the ability to identify the reasonable compromises is essential
- Integrity also implies basic honesty
    - Truthfulness - meeting responsibilities concerning truth telling
    - Trustworthiness - meeting responsibilities concerning trust

2.17.2. Self Respect

- Self respect refers to the virtue of properly valuing oneself in morally appropriate ways. Valuing oneself property is essential in finding meaning of one's life and work
- It is defined as valuing oneself in morally suitable ways.
- Self-respect includes (a) recognition, which means respect to others, their ideas, decisions, ability, and rights and (b) appraisal, which means properly valuing ourselves as to how well we face moral standards and our personal commitments (aims). An intensive but balanced feeling of self-respect is sense of honor.
- This includes intense agony and guilt for wrong doings. Self-control is a virtue of maintaining personal discipline (self-regulation).
- Courage is a bye-product of self-respect, which makes a person face the hardship in rational way
- Self-respect is different from self-esteem in the following manner:

Self-respect	*Self-esteem*
1. A moral concept	1. A psychological concept
2. Valuing oneself in morally-suitable ways	2. Having a positive attitude towards oneself. It may be excessive or un-warranted or normal
3. It includes virtues of recognition and appraisal. It promotes virtues of sense of honor, self-control and courage	

- **The other related Virtues include:**
    - **A sense of honor**
    - **Self control**
    - **Courage and**
    - **Good judgment**
- **A sense of honor**
    - **It is also known as dignity. It is the virtue of** stressing the emotions of self respect and also its minimum requirements. This involves pride in maintaining high professional standards, shame for failing to meet minimum standards of professionalism and guilty of wrongdoing
- **Self control**
    - It is a virtue of maintaining personal discipline. It means a strong will and motivation and avoidance of fear, hatred, lack of efforts, temptation, self-deception, and emotional response. It encompasses courage and good judgment also. Self-respect promotes self-control.
- **Courage**

- **It is the virtue of controlling dangers and difficult tasks in rational ways and with self control**
- Courage supports self respect and in turn self respect support courage
- **Courage is classified into three types, based on the types of risks, namely**

a) **Physical courage:** In physical courage, the thrust is on the adequacy of the physical strength, including the muscle power and armaments. People with high adrenalin, may be prepared to face challenges for the mere 'thrill' or driven by a decision to 'excel'.

b) **Social courage:** The social courage involves the decisions and actions to change the order, based on the conviction for or against certain social behaviors. This requires leadership abilities, including empathy and sacrifice, to mobilize and motivate the followers, for the social cause.

c) **Intellectual courage:** The intellectual courage is inculcated in people through acquired knowledge, experience, games, tactics, education, and training. In professional ethics, courage is applicable to the employers, employees, public, and the press.

- **Good Judgment**
  - **It is the practical wisdom in moral matters of all vitues, including sel respect.**
  - **It is very essential to strike a balance between any two extremes, such as one's concern for self oriented goods (like income and prestige) and for society oriented goods (like producing worthy products)**

2.18. Self Interest

- Self-interest is being good and acceptable to oneself. It is pursuing what is good for oneself. It is very ethical to possess self-interest. As per utilitarian theory, this interest should provide for the respect of others also. Duty ethics recognizes this aspect as duties to ourselves. Then only one can help others.
- Right ethicist stresses our rights to pursue our own good. Virtue ethics also accepts the importance of self-respect as link to social practices.
- In Ethical Egoism, the self is conceived in a highly individualistic manner. It says that every one of us should always and only promote one's own interest. The ethical egoists do not accept the well being of the community or caring for others. However this self interest should not degenerate into egoism or selfishness, i.e., maximizing only own well in the pursuit of self-interest.
- The ethical egoists hold that the society benefits to maximum when (a) the individuals pursue their personal good and (b) the individual organizations pursue maximum profit in a competitive enterprise.
- This is claimed to improve the economy of the country as a whole, besides the individuals. In such pursuits, both individuals and organizations should realize that independence is not the only important value. We are also interdependent, as much as independent. Each of us is vulnerable in the society.
- Self-respect includes recognition of our vulnerabilities and interdependencies. Hence, it is compatible with caring for ourselves as well as others.
- Self-interest is necessary initially to begin with. But it should be one of the prime motives for action; the other motive is to show concern for others, in the family as well as society. One's self-interest should not harm others. The principles of 'Live and let (others) live', and 'reasonably fair competition' are recommended to professionals by the ethicists.

2.19. Custom

- **Ethical Pluralism**: Various cultures in our pluralistic society lead to tolerance for various customs, beliefs, and outlooks. Accordingly ethical pluralism also exists. Although many moral attitudes appear to be reasonable, the rational and morally concerned people cannot fully accept any one of the moral perspectives. There are many varied moral values, which allow variation in the understanding and application of values by the individuals or groups in their everyday transactions. It means that even reasonable people will not agree on all moral issues and professional ethics.
- **Ethical Relativism**: According to this principle, actions are considered morally right when approved by law or custom, and wrong when they violate the laws or customs. The deciding factor is the law or the customs of the society. Should we accept the principle of relativism or not?

A few reasons to accept this are explained in the following paragraphs:

1. Laws appear to be objective ways for judging values. The laws and customs tend to be definite, clear and real, but not always. Further moral reasons allow objective criticism of laws, as being morally lacking. For example, the Apartheid laws of South Africa violated the human rights of the native Africans. No legal protection was available for native citizens for a long time. Now, of course, these laws have been repealed.

2. Ethical relativism assumes that the values are subjective at the cultural level. Moral standards also vary from culture to culture. The objectivity is supported by the existing laws of that society. The relative morality accepted, supports the virtue of tolerance of differences among societies. This argument is also not fully acceptable. As per ethical relativism, the actions and laws of the Nazis and Hitler who vowed on Anti-Semitism and killed several million Jews would be accepted as right.

3. Moral relationalism or moral contextualism: According to this, the moral judgments must be made in relation to certain factors, which may vary from case to case. The morally important factors for making judgments include the customs and laws. The virtue ethicists hold that the practical wisdom should prevail upon assessing the facts and in the judgment.

- This principle was accepted by the early anthropologists because they had a specific tendency to over-stress the scope of moral difference between cultures. The human sacrifices and cannibalism were accepted. But the modern anthropologists insist that all cultures shall exhibit the virtue of social welfare and safety against needless death or physical or mental harm. Moral differences were based on the circumstances and facts and not on the difference in moral attitudes. For example, the pharaohs buried the live attendants along with their dead king with the belief that they would continue to serve the king in his afterlife.

2.20. Religion

- Religions have played major roles in shaping moral views and moral values, over geographical regions. Christianity has influenced the Western countries, Islam in the Middle-East countries, Buddhism and Hinduism in Asia, and Confucianism in China. Further, there is a strong psychological link between the moral and religious beliefs of people following various religions and faiths.
- Religions support moral responsibility. They have set high moral standards. Faith in the religions provides trust and this trust inspires people to be moral. The religions insist on tolerance and moral concern for others. Many professionals who possess religious beliefs are motivated to be morally responsible.
- Each religion lays stress on certain high moral standards. For example, Hinduism holds polytheistic (many gods) view, and virtues of devotion and surrender to high order. Christianity believes in one

deity and emphasizes on virtues of Love, Faith, and Hope. Buddhism is non-theistic and focuses on compassion and Islam on one deity and adherence of ishan (piety or pursuit of excellence) and prayer. Judaism stresses the virtue of 'tsedakah' (righteousness). But many religious sects have adopted poor moral standards, e.g., many religious sects do not recognize equal rights for women.

- The right to worship is denied for some people. People are killed in the name of or to promote religion. Thus, conflicts exist between the 'secular' and religious people and between one religion and another. Hence, religious views have to be morally scrutinized.

2.20.1. Divine Command Ethics

- As per this principle, the right action is defined by the commands by God. It implies that to be moral, a person should believe in God and an action is right only if it is commanded by God. There are some difficulties in this approach, namely, (a) whether God exists or not is not clear. (b) How to know what are the God's commands? and (c) How to verify the genuineness of the commands?
- Further, religions such as Hinduism, Islam, and Christianity accept the existence of God. But Buddhism, Taoism, and Confucianism adopt only faith in a right path and do not believe in God.
- Socrates was said to have argued that God, an entity which is responsible, morally good, and beyond fear or favor, would not command murder, rape, torture, immoral activities, and even mass suicide. Many such crimes were committed in the name of God then and continue even now in different parts of the world. Some Western leaders had claimed that God had commanded them to invade against the Middle-East countries. If anyone claims to have obtained commands from God to kill people merciless, then we have to conclude that the person is not religious but insane.

2.20.2. Uses of Ethical Theories

CASE STUDY: CHOICE OF THE THEORY

- The choice of the ethical theory to study a problem is illustrated herein with an example. In tackling ethical problems, we can apply all the theories and analyze the actions and results from different angles and see what result each theory gives rise to. This enables us to examine the problem in different perspectives. Many a time, the result will be the same though we have applied various theories
- Case: A chemical plant near a small town is discharging hazardous wastes into the fields nearby. The ground water gets contaminated and significant health problems surface in the community. Since harm is caused to the residents, the action is unethical as per rights ethics. The agriculturists who have the agrarian right of water supply have been over looked. The pollutants may endanger their profession and welfare. Hence, **rights ethics** also concludes that the action is unethical.
- The effects of polluted water and the cost to purify the water by the municipality may outweigh the economic benefits of the plant. Hence, the **utilitarian analysis** leads to the same conclusion.
- The groundwater harms the people and caused health problems. Hence, discharging the pollutants is unethical as per **duty ethics**. Generally, because the rights of the individuals should weigh strongly than the needs of the society as a whole, rights and duty ethics take precedence over utilitarian considerations.
- Caution is necessary in applying theory of **virtue ethics**. When we use the word 'honor', we mean it to be a measure of dignity and integrity. It is a positive virtue. When it points to 'pride' it is not a virtue and has a negative connotation. History abounds with examples of war, which have been fought and atrocities were committed on innocent people in order to preserve the honor (pride) of an individual or a nation. In using virtue ethics, we have to ensure that the traits of virtue are actually virtuous and will not lead to negative consequences.

Table 2.1. Summary of ethical theories

Theory	Versions	Underlying Concept
Virtue ethics	Basic concept	It regards actions as right that manifests good character traits (virtues) and regards actions as bad that display bad character traits (vices).
	Aristotle's theory of 'Golden Mean'	Virtues are tendencies to find the 'Golden Mean' between of excess (i.e., too much) and deficiency (i.e., too little).
	MacIntyre's version of virtue theory	The virtues should be related with social practices i.e., corporate activities that are aimed at achieving public goods.
Utilitarianism	*Basic concept*	It is concerned to promote, or at least protect the greatest good for the greatest number of people.
	Mill's Act utilitarianism	It focuses on individual actions rather than general rules.
	Brant's Rule utilitarianism	It holds that moral rules are more important than an individual's action.
Duty ethics	*Basic concept*	It contends that there are moral duties that should be performed regardless of whether these acts lead to the most good.
	Kant's version	According to him, those actions are right that equally respect each human person as a moral agent.
	John Rawls's version	According to him, valid principles of duty are those that would be voluntarily agreed upon by all rational persons in an imaginary 'contracting' situation.
Rights ethics	*Basic concept*	It holds that those actions are good that respect the rights of the individual.
	Locke's version	According to him, humans have human rights to life, liberty, and the property generated by one's labor.
	Melden's version	According to him, welfare rights are rights to community benefits needed for living a minimum decent human life.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

3.1. Engineering as Experimentation

- Experimentation is commonly recognized as playing an essential role in the design process.
- Preliminary tests or simulations are conducted from the time it is decided to convert a new engineering concept into its first rough design.
- Materials and processes are tried out, usually employing formal experimental techniques.
- Such tests serve as the basis for more detailed designs, which in turn are tested.
- At the production stage further tests are run, until a finished product evolves.
- The normal design process is thus iterative, carried out on trial designs with modifications being made on the basis of feedback information acquired from tests.
- However, each engineering project taken as a whole may be viewed as an experiment.

3.1.1. Similarities to Standard Experiments

Several features of virtually every kind of engineering practice combine to make it appropriate to view engineering projects as experiments.

a) **Partial Ignorance**: Any project is carried out in partial ignorance. There are uncertainties in the
   - Abstract model used for the design calculations;
   - Precise characteristics of the materials purchased;
   - Precision of materials processing and fabrication;
   - About the nature of the stresses the finished product will encounter.

   ✓ Engineers do not wait until all the relevant facts are in before commencing work.
   ✓ The theoretical exploration and laboratory testing must be avoided for the sake of moving ahead on a project.
   ✓ But an engineer's success lies precisely in the ability to complete tasks safely with only a partial knowledge of scientific laws about nature and society.

b) **Uncertainty:**

✓ The final outcomes of engineering projects are also uncertain as in experiments. Often in engineering it is not even known the possible outcomes, and great risks may also occur in simple projects.
✓ For example, A reservoir may do damage to a region's social structure or to its ecosystem. It may not even serve its intended purpose if the dam leaks or breaks. An canal may bring about a population explosion in a region where it is the only source of water, creating dependency and vulnerability without adequate safeguards.
✓ A jumbo airplane may bankrupt the small airline that bought it as a status symbol.
✓ A special-purpose fingerprint reader may find its main application in the identification and surveillance of protester by dictatorial command.
✓ A nuclear reactor, the scaled-up version of a successful smaller model, may exhibit unexpected problems that cause danger to the surrounding population, leading to its untimely shutdown at great cost to owner and consumers alike.
✓ A hair dryer may have exposed the user to lung damage from the asbestos insulation in its barrel.

c) **Continuous Monitoring**:

- ✓ Effective engineering relies on knowledge gained about products both before and after they leave the factory. Ongoing success in engineering depends on gaining new knowledge, as ongoing success in experimentation.
- ✓ Monitoring is thus as essential to engineering as it is to experimentation in general. To monitor is to make periodic observations and tests to check for both successful performance and accidental side effects.
- ✓ But as the ultimate test of a product's efficiency, safety, cost-effectiveness, environmental impact, and visual value lies in how well that product functions within society,
- ✓ **M**onitoring cannot be restricted to the in-house development or testing phases of an engineering venture. It also extends to the stage of client use.
- ✓ As in experimentation, both the intermediate and final results of an engineering project deserve analysis if the correct lessons are to be learned from it.

d) Learning from the Past

- ✓ Engineers learn from their own earlier design and operating results, as well as from those of other engineers
- ✓ Lack of established channels of communication, omitted satisfaction in not asking for information, embarrassment at failure or fear of litigation
- ✓ These examples illustrate why it is not enough for engineers to rely on handbooks and computer programs without knowing the limits of the tables and algorithms underlying their favorite tools

i. The ***Titanic*** lacked a sufficient number of lifeboats decades after most of the passengers and crew on the steamship ***Arctic*** had perished because of the same problem.

ii. "Complete lacks of protection against impact by shipping caused Sweden's worst ever bridge collapse on Friday as a result of which eight people were killed." Thus reported the ***New Civil Engineer*** on January 24, 1980. Engineers now recommend the use of floating concrete bumpers that can deflect ships, but that recommendation is rarely heeded as seen by the 1993 collapse of the Bayou Canot bridge that cost 43 passengers of the ***Sunset Limited*** their lives.

iii. Valves are notorious for being among the least reliable components of hydraulic systems.It was a pressure relief valve, and a lack of definitive information regarding its open or shut state, which contributed to the nuclear reactor accident at Three Mile Island on March 28, 1979. Similar malfunctions had occurred with identical valves on nuclear reactors at other locations.

iv. The required reports had been filed with Babcock and Wilcox, the reactor's manufacturer, but no attention had been given to them.

3.1.2. Contrasts with Standard Experiments

a. **Experimental Control.**

- In standard experiments, members for study are selected into two groups namely A and B at random. Group A are given special treatment. The group B is given no treatment and is called the 'controlled group'. But they are placed in the same environment as the other group A. This process is called the experimental control. This practice is adopted in the field of medicine.

- In engineering, this does not happen, except when the project is confined to laboratory experiments. This is because it is the clients or consumers who choose the product, exercise the control. It is not possible to make a random selection of participants from various groups. In engineering, through random sampling, the survey is made from among the users, to assess the results on the product.
- For example, social scientists monitor and collect data on differences and similarities between existing educational systems that were not initially set up as systematic experiments.
- In doing , So they regard the current diversity of systems as constituting what has been called a *natural Experiment*. Similarly, we think that engineering can be appropriately viewed as just such a natural experiment using human subjects
- Thus the above discussion justifies the view of engineering as a social experimentation.
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b. **Humane touch**:
   - Engineering experiments involve human souls, their needs, views, expectations, and creative use as in case of social experimentation. This point of view is not agreed by many of the engineers. But now the quality engineers and managers have fully realized this humane aspect.

c. **Informed Consent.**
   - Viewing engineering as an experiment on a societal scale places the focus on the human beings affected by technology, for the experiment is performed on persons, not on inanimate objects.
   - Engineering closely parallels medical testing of new drugs or procedures on human subjects.
   - Society has recently come to recognize the primacy of the subject's safety and freedom of choice as to whether to participate in medical experiments.
   - Current medical practice has increasingly tended to accept as fundamental the subject's moral and legal rights to give informed consent before participating in an experiment, contemporary engineering practice is only beginning to recognize those rights.
   - We believe that the problem of informed consent, which is so critical to the concept of a properly conducted experiment involving human subjects, should be the keystone in the interaction between engineers and the public.
   - When a manufacturer sells a new device to a knowledgeable firm that has its own engineering staff, there is usually an agreement regarding the shared risks and benefits of trying out the technological innovation.
   - **Informed consent is understood as including two main elements:**
     - **knowledge:** the human subjects should be given not only the information they request, but all the information needed to make a reasonable decision.
     - **Voluntariness**. The human subjects must enter into the experiment without being subjected to force, fraud, or dishonesty. Respect for the fundamental rights of nonconforming minorities and compensation for harmful effects are taken for granted here.

- ✓ The mere purchase of a product does not constitute informed consent, any more than does the act of showing up on the occasion of a medical examination. The public and clients must be given information about the practical risks and benefits of the process or product in terms they can understand. Supplying complete information is neither necessary nor in most cases possible.
- ✓ We do not propose a process resembling the preparation and release of environmental impact reports. We favor the kind of sound advice a responsible physician gives a patient when prescribing a course of drug treatment that has possible side effects. The physician must search beyond the typical sales brochures from drug manufacturers for adequate information; hospital management must allow the physician the freedom to undertake different treatments for different patients, as each case may constitute a different "experiment" involving different circumstances; finally, the patient must be readied to receive the information.
- ✓ Likewise, engineers cannot succeed in providing essential information about a project or product unless there is cooperation by superiors and also openness on the part of those who should have the information.

- ✓ Example:

    - When Northern States Power Company (Minnesota) was planning a new power plant, it got in touch with local citizens and environmental groups before it committed large sums of money to preliminary design studies. The company was able to present convincing evidence regarding the need for a new plant and then suggested several sites. Citizen groups responded with a site proposal of their own. The latter was found acceptable by the company. Thus, informed consent was sought from and voluntarily given by those the project affected, and the unfriendly and prolonged battles so common in other cases where a company has already invested heavily in decisions based on engineering studies alone was avoided.

- ✓ ***Valid consent* defined by the following conditions:**

1. The consent was given voluntarily.
2. The consent was based on the information that a rational person would want, together with any other information requested, presented to them in understandable form.
3. The consenter was competent (not too young or mentally ill) to process the information and make rational decisions.

We suggest two requirements for situations in which the subject cannot be readily identified as an individual:

4. Information that a rational person would need, stated in understandable form, has been widely disseminated.
5. The subject's consent was offered in proxy by a group that collectively represents many subjects of like interests, concerns, and exposure to risk.

3.1.3. **Knowledge Gained.**

- According to a valuable interpretation of the social-experimentation paradigm by Taft Broome. "Engineering projects are experiments that are not necessarily designed to produce very much knowledge," whereas, Scientific experiments are conducted to gain new knowledge.

- The final outcomes of almost all engineering experiments are unexpected outcomes.
- The unexpected outcomes send us on a search for new knowledge—possibly involving an experiment of the scientific type.
- It is also viewed that the best outcome is the one, who confirms that we are right about something. Always best outcome should give us something new.
- Engineers should learn not only from their own earlier design and operating results but also from those of other Engineers
- Engineers cannot rely only on Handbooks. They should demand updated and detailed information at every stage of a project history.
- At the outset , from the subject point of view , we are concerned about the manner in which the experiment is conducted, such as that valid consent of human subjects is sought, safety measures are taken, and means exist for terminating the experiment at any time and providing all participants a safe exit.

3.2. Engineers as Responsible Experimenters

What are the responsibilities of engineers to society?

- ✓ Engineers are the main technical enablers or facilitators; they are far from being the sole experimenters.
- ✓ Their responsibility is shared with management, the public, and others.
- ✓ The other unique position to monitor projects, to identify risks, and to provide clients and the public with the information needed to make reasonable decisions.

General Features of morally responsible Engineers are:

From the perspective of engineering as social experimentation, four features characterize what it means to be a responsible person while acting as an engineer.

- ✓ **A conscientious commitment to live by moral values:** A primary obligation to protect the safety of human subjects and respect their right of consent
- ✓ **A comprehensive perspective** A constant awareness of the experimental nature of any project, imaginative forecasting of its possible side effects, and a reasonable effort to monitor them
- ✓ **Autonomy:** Autonomous, personal involvement in all steps of a project
- ✓ **Accountability :** Accepting accountability for the results of a project

3.2.1. Conscientiousness

- ✓ Conscientiousness means commit themselves to live according to moral values
- ✓ By conscientious moral commitment we mean sensitivity to the full range of moral values and responsibilities relevant to a given situation,
- ✓ Also engineers should have the willingness to develop the skill and apply the effort needed to reach a reasonable balance among those considerations.
- ✓ Conscientiousness implies consciousness: open eyes, open ears, and an open mind.
- ✓ There are obvious benefits in terms of cautious self-interest and concern for one's family that make it easy to emphasize as primary the obligations to one's employer.
- ✓ Conceiving engineering as social experimentation restores the vision of engineers as guardians of the public interest, whose professional duty it is to hold the safety, health, and welfare of those affected by engineering projects.

- ✓ And this helps to ensure that such safety and welfare will not be disregarded in the quest for new knowledge, the rush for profits, a narrow adherence to rules, or a concern over benefits for the many that ignores harm to the few.
- ✓ The role of social guardian should not suggest that engineers force their own views of the social good on society.
- ✓ As with medical experimentation on humans, the social experimentation involved in engineering should be restricted by the participant's voluntary and informed consent.

3.2.2. Comprehensive Perspective

- ✓ Conscientiousness is blind without relevant factual information. Hence showing moral concern involves a commitment to obtain and properly assess all available information that is relatable to meet moral responsibility.
- ✓ For example, in designing a heat exchanger, if I ignore the fact that it will be used in the manufacture of a potent, illegal hallucinogen, I am showing a lack of moral concern. One should be aware of the wider implications of one's work that makes participation in, say, a design project for a super weapon morally problematic—and that makes it sometimes convenient for engineers self-deceivingly to ignore the wider context of their activities, a context that may rest uneasily with conscience.
- ✓ Another way of simple context of one's work results from the ever-increasing specialization and division of labor that makes it easy to think of someone else in the organization as responsible for what otherwise might be a bothersome personal problem.
- ✓ Engineering as social experimentation points out the importance of context, it also urges the engineer to view his or her specialized activities in a project as part of a larger whole having a social impact:
- ✓ An impact that may involve a variety of unintended effects.
- ✓ It might be said that the goal is to practice "preventive technology," which parallels the idea of preventive medicine: The solution to the problem is not in successive cures to successive science-caused problems; it is in their prevention."
- ✓ No amount of disciplined and imaginative foresight, however, can anticipate all dangers. Because engineering projects are inherently experimental in nature, they need to be monitored on an ongoing basis from the time they are put into effect.
- ✓ Individual practitioners cannot privately conduct full-blown environmental and social impact studies, but they can choose to make the extra effort needed to keep in touch with the course of a project after it has officially left their hands. This is a mark of personal identification with one's work, a notion that leads to the next aspect of moral responsibility.

3.2.3. Moral Autonomy

- ✓ People are morally autonomous when their moral conduct and principles of action are their own, in a special sense derived from Kant: **Moral beliefs and attitudes should be held on the basis of critical reflection rather than passive adoption of the particular conventions of one's society, church, or profession. This is often what is meant by "authenticity" in one's commitment to moral values**
- ✓ . Those beliefs and attitudes, moreover, must be integrated into the core of an individual's personality in a manner that leads to committed action.

- ✓ It is a comfortable illusion to think that in working for an employer, and thereby performing acts directly serving a company's interests, one is no longer morally and personally identified with one's actions. Selling one's labor and skills may make it seem that one has thereby disowned and forfeited power over one's actions.
- ✓ As an experimenter, an engineer is exercising the sophisticated training that forms the core of his or her identity as a professional.
- ✓ Moreover, viewing an engineering project as an experiment that can result in unknown consequences should help inspire a critical and questioning attitude about the adequacy of current economic and safety standards. This also can lead to a greater sense of personal involvement with one's work.
- ✓ The magnitude of moral autonomy is to be experienced by engineers in highly influenced by the attitude of company's management
- ✓ When there is threat for engineer's moral autonomy, then engineers can look for moral support from their professional societies and other outside organization

3.2.4. Accountability

- ✓ The term accountability means being responsible, liable, answerable or duty-bounded
- ✓ The term more properly refers generally of being willing to submit one's actions to moral scrutiny and be open and responsive to the assessments of others.
- ✓ It involves willingness to present morally strong reasons for one's conduct when called on to do so in appropriate circumstances.
- ✓ Accountability was documented by some famous experiments conducted by Stanley Milgram during the 1960s. Subjects would come to a laboratory believing they were to participate in a memory and learning test. In one variation, two other people were involved, the "experimenter" and the "learner." The experimenter was regarded by the subject as an authority figure, representing the scientific community. He or she would give the subject orders to administer electric shocks to the "learner" whenever the latter failed in the memory test. The subject was told the shocks were to be increased in magnitude with each memory failure. All this, however, was a dishonesty.
- ✓ When the subjects were placed in an adjoining room separated from the "learner" by a shaded glass window, more than half were willing to follow orders to the full extent: giving the maximum electric jolt of 450 volts. The same results occurred when the subjects were allowed to hear the (apparently) pained screams and protests of the "learner," screams and protests that became intense from 130 volts on. There was a striking difference, however, when subjects were placed in the same room within touching distance of the "learner." Then the number of subjects willing to continue to the maximum shock dropped by one-half.
- ✓ Milgram explained these results by citing a strong psychological tendency to be willing to abandon personal accountability when placed under authority.
- ✓ He saw his subjects ascribing all initiative, and thereby all accountability, to what they viewed as Legitimate authority.
- ✓ The separation between causal influence and moral accountability is common in business and the professions, and engineering is no exception.
- ✓ **Such a psychological break is encouraged by several prominent features of contemporary engineering practice.**

- ✓ First, large-scale engineering projects involve fragmentation of work. Each person makes only a small contribution to something much larger. The final product is often physically removed from one's immediate workplace, creating the kind of "distancing" that Milgram identified as encouraging a lessened sense of personal accountability.
- ✓ Second, corresponding to the fragmentation of work is a vast diffusion of accountability within large institutions.
- ✓ Third, there is often pressure to move on to a new project before the current one has been operating long enough to be observed carefully. This promotes a sense of being accountable only for meeting schedules.
- ✓ Fourth, the contamination of malpractice suits currently afflicting the medical profession is carrying over into engineering.
- ✓ Engineers are blameworthy for all the harmful side effects of the projects they work on, even though they partially cause those effects simply by working on the projects. That would be to confuse accountability with *blameworthiness,* and also to confuse *causal* responsibility with *moral* responsibility

3.3. Code of Ethics

3.3.1. Importance of Codes

- ✓ Codes of ethics state the moral responsibilities of engineers by the profession and as represented by a professional society. Because they express the profession's collective commitment to ethics.
- ✓ Codes are important, not only in stressing engineers' responsibilities but also in supporting the freedom needed to meet them.

3.3.2. Positive functional roles of Code of Ethics

- ✓ **Codes of ethics play at least eight essential roles:**
- ✓ serving and protecting the public, providing guidance, offering inspiration, establishing shared standards, supporting responsible professionals, contributing to education, deterring wrongdoing, and strengthening a profession's image.
    a. ***Serving and protecting the public.*** Engineering involves advanced expertise that professionals have and the public lacks, and also considerable dangers to a vulnerable public. Trust and trustworthiness are essential. A code of ethics functions as a commitment by the profession as a whole that engineers will serve the public health, safety, and welfare. In one way or another, the remaining functions of codes all contribute to this primary function.
    b. ***Guidance.*** Codes provide helpful guidance by communicating the main obligations of engineers. Because codes should be brief to be effective, they offer mostly general guidance. More specific directions may be given in supplementary statements or guidelines, which tell how to apply the code.
    c. ***Inspiration.*** Because codes express a profession's collective commitment to ethics, they provide a positive stimulus (motivation) for ethical conduct. In a powerful way, they voice what it means to be a member of a profession committed to responsible conduct in promoting the safety, health, and welfare of the public. It expresses a collective commitment to the public good that inspires individuals to have similar aspirations.

d. ***Shared standards.*** The diversity of moral viewpoints among individual engineers makes it essential that professions establish explicit standards, in particular minimum (but hopefully high) standards. In this way, the public is assured of a standard of excellence on which it can depend, and professionals are provided a fair playing field in competing for clients.

e. ***Support for responsible professionals.*** Codes give positive support to professionals seeking to act ethically. A publicly announced code allows an engineer, under pressure to act unethically, to say: "I am bound by the code of ethics of my profession, which states that . . ." This by itself gives engineers some group backing in taking stands on moral issues. Moreover, codes can potentially serve as legal support for engineers criticized for living up to work-related professional obligations.

f. ***Education and mutual understanding.*** Codes can be used by professional societies and in the classroom to prompt discussion and reflection on moral issues. Widely circulated and officially approved by professional societies, codes encourage a shared understanding among professionals, the public, and government organizations about the moral responsibilities of engineers.

g. ***Deterrence and discipline.*** Codes can also serve as the formal basis for investigating unethical conduct. Where such investigation is possible, a deterrent for immoral behavior is thereby provided. Such an investigation generally requires paralegal proceedings designed to get at the truth about a given charge without violating the personal rights of those being investigated. Unlike the American Bar Association and some other professional groups, engineering societies cannot by themselves revoke the right to practice engineering in the United States. Yet some professional societies do suspend or expel members whose professional conduct has been proven unethical, and this alone can be a powerful sanction when combined with the loss of respect from colleagues and the local community that such action is bound to produce.

h. ***Contributing to the profession's image.*** Codes can present a positive image to the public of an ethically committed profession. Where warranted, the image can help engineers more effectively serve the public. It can also win greater powers of self regulation for the profession itself, while lessening the demand for more government regulation. The reputation of a profession, depends on reputation of an individual professional or a corporation, is essential in sustaining the trust of the public.

3.3.3. Abuse of Codes

- ✓ When codes are not taken seriously within a profession, they amount to a kind of window dressing that ultimately increases public doubt about the profession.
- ✓ The worst abuse of engineering codes is to restrict honest moral effort on the part of individual engineers to preserve the profession's public image and protect the status quo. And an excessive interest in protecting the status quo may lead to a distrust of the engineering profession on the part of both government and the public.
- ✓ The best way to increase trust is by encouraging and helping engineers to speak freely and responsibly about public safety and well-being. This includes a tolerance for criticisms of the codes themselves, rather than allowing codes to become sacred documents that have to be accepted uncritically.

- ✓ On rare occasions, abuses have discouraged moral conduct and caused serious harm to those seeking to serve the public. For example, two engineers were expelled from American Society of Civil Engineers (ASCE) for violating a section of its code forbidding public remarks critical of other engineers. Yet the actions of those engineers were essential in uncovering a major bribery scandal related to the construction of a dam for Los Angeles County.
- ✓ Consider the following entry in the pre-1979 versions of the NSPE code: The engineer "shall not solicit or submit engineering proposals on the basis of competitive bidding." This prohibition was felt by the NSPE to best protect the public safety by discouraging cheap engineering proposals that might slight safety costs to win a contract. The Supreme Court ruled, however, that it mostly served the self-interest of established engineering firms and actually hurt the public by preventing the lower prices that might result from greater competition (*National Society of Professional Engineers v. United States* [1978]).

3.3.4. Limitations of Codes

- ✓ Codes are no substitute for individual responsibility in grappling with concrete dilemmas.
- ✓ General and vague wordings. Many statements are general in nature and hence unable to solve all problems.
- ✓ Not applicable to all situations. Codes are not sacred, and need not be accepted without criticism. Tolerance for criticisms of the codes themselves should be allowed.
- ✓ Often have internal conflicts. Many times, the priorities are clearly spelt out, e.g., codes forbid public remarks critical of colleagues (engineers), but they actually discovered a major bribery, which might have caused a huge loss to the exchequer.
- ✓ They cannot be treated as final moral authority for professional conduct. Codes have flaws by commission and omission. There are still some grey areas undefined by codes. They can not be equated to laws. After all, even laws have loopholes and they invoke creativity in thelegal practitioners.
- ✓ Only a few enroll as members in professional society and non-members can not be compelled.
- ✓ Even as members of the professional society, many are unaware of the codes
- ✓ Codes are said to be coercive. They are sometimes claimed to be threatening and forceful.
- ✓ This last limitation of codes connects whether professional groups or entire societies can create sets of standards for themselves that are both morally authoritative and not open to criticism, or whether group standards are always open to moral scrutiny in light of wider values familiar in everyday life. This is the issue of ethical relativism.

Ethical Relativism:

- ✓ "A code of professional ethics may be thought of as a collective recognition of the responsibilities of the individual practitioners"; codes cannot be "used in cookbook fashion to resolve complex problems," but instead they are "valuable in outlining the factors to be considered."
- ✓ Unger takes codes very seriously as a profession's shared voice in articulating the responsibilities of its practitioners. A good code provides valuable focus and direction.
- ✓ Michael Davis says they are morally authoritative. "A code of ethics is, as such, not merely good advice or a statement of aspiration. It is a standard of conduct which, if generally realized in the practice of a profession, imposes a *moral responsibility* on each member of the profession to act accordingly."

- ✓ Davis also called it as ethical conventionalism, which says that moral values are entirely relative to and reducible to customs—to the conventions, laws, and norms of the group to which one belongs.
- ✓ Anthropologist Ruth Benedict, "We recognize that morality differs in every society, and is a convenient term for socially approved habits. Mankind has always preferred to say, 'It is morally good,' rather than 'It is habitual.'
- ✓ Ethical relativism also seems to allow any group of individuals to form its own society with its own conventions. Again, an engineer might be a member of one or more professional societies, a weapons development corporation and a pacifist religious tradition, and the customs of these groups in matters of military work might point in different directions.
- ✓ Some moral requirements are indeed established by mutual agreements. Just as laws establish the legal and moral permissibility of driving on the right side of the road (in the United States) or the left side (in England), some requirements in engineering codes of ethics create responsibilities.
- ✓ Unger is correct in holding that many of the entries in codes of ethics state responsibilities that would exist regardless of the code—for example, to protect the safety, health, and welfare of the public. Davis is correct that some parts of codes are conventions arrived at by mutual agreement within the profession.

3.3.5. Justification of Codes

- ✓ A sound professional code will stand up to three tests: (1) It will be clear and coherent; (2) it will organize basic moral values applicable to the profession in a systematic and comprehensive way, highlighting what is most important; and (3) it will provide helpful and reasonable guidance that is compatible with our most carefully considered moral convictions (judgments, intuitions) about concrete situations. In addition, it will be widely accepted within the profession.
- ✓ Testing the code in light of an ethical theory will need to take close account of both the morally relevant features of engineering and the kinds of public goods engineering seeks to provide for the community.
- ✓ Justified professional code will take account of both the profession's public good and social frame works and institutional settings.

3.4. A Balanced Outlook on Law

The 'balanced outlook on law' in engineering practice stresses the necessity of laws and regulations and also their limitations in directing and controlling the engineering practice. Laws are necessary because, people are not fully responsible by themselves and because of the competitive nature of the free enterprise, which does not encourage moral initiatives. Laws are needed to provide a minimum level of compliance.

The following codes are typical examples of how they were enforced in the past:

3.4.1. Code of Builders by Hammurabi

Hammurabi, as king of Babylon, was concerned with strict order in his realm, and he decided that the builders of his time should also be governed by his laws. In 1758 BCE he declared:

"If a builder has built a house for a man and has not made his work sound, and the house which he has built has fallen down and so caused the death of the householder, that builder shall be put to death. If a builder has built a house for a man and does not make his work perfect and the wall bulges, that builder shall put that wall into sound condition at his own cost." This code was expected to put in self-regulation seriously in those years.

One of the greatest moral problems in engineering, and one fostered by the very existence of minutely detailed rules, is that of ***minimal compliance***. This can find its expression when companies or individuals search for loopholes in the law. That will allow them to barely keep to its letter even while violating its spirit.

Minimal compliance led to the tragedy of the *Titanic*:

Why should that ship have been equipped with enough lifeboats to accommodate all its passengers and crew when British regulations at the time required only a lower minimum, even with smaller ships in mind?

Steam Boat Code in USA

Whenever there is crisis we claim that there ought to be law to control this. Whenever there is a fire accident in a factory or fire cracker's store house or boat capsize we make this claim, and soon forget. Laws are meant to be interpreted for minimal compliance. On the other hand, laws when amended or updated continuously would be counterproductive. Laws will always lag behind the technological development. The regulatory or inspection agencies such as Environmental authority of India can play a major role by framing rules and enforcing compliance.

In the early 19th century, a law was passed in USA to provide for inspection of the safety of boilers and engines in ships. It was amended many times and now the standards formulated by the American Society of Mechanical Engineers are followed.

3.4.2. Regulation Societies

Lawmakers cannot be expected always to keep up with technological development. Nor would we necessarily want to see laws changed with each innovation. Instead we empower rulemaking and inspection agencies like the Food and Drug Administration (FDA), Federal Aviation Agency (FAA), and the Environmental Protection Agency (EPA) are examples of these in the United States. Although they are nominally independent in that they belong neither to the judicial nor the executive branches of government, their rules have, for all practical
purposes, the effect of law, but they are headed by political appointees.

Industry tends to complain that excessive restrictions are imposed on it by regulatory agencies. But one needs to reflect on why regulations may have been necessary in the first place. For example, the U.S. Consumer Product Safety Commission's rule for baby cribs, which specifies that "the distance between components (such as slats, spindles, crib rods, and corner posts)shall not be greater than inches at any point." This rule came about because some manufacturers of baby furniture had neglected to consider the danger of babies strangling in cribs or had neglected to measure the size of babies' heads.

When the Environment protection Agency (EPA) adopted rules for asbestos emissions in 1971, it was recognized that strict numerical standards would be impossible to disseminate. Asbestos dispersal and intake, for example, are difficult to measure in the field. So, EPA many years ago specified a set of work practice for example, that asbestos should be wetted down before handling and disposed of carefully to keep emissions to a minimum

Modifications in the Clean Air Act eventually permitted the EPA to issue enforceable rules on work practices, and now the Occupational Safety and Health Administration is also involved.

3.4.3. What is law?

- ✓ **Law is a body of rules of action prescribe by a controlling legal authority and having binding legal force**
- ✓ **Law means all the rules established by authority or custom for regulating the behavior of members of a community or country**
- ✓ **It is a solemn expression of the will of a supreme power the authority**
- ✓ **Law is a system of rules and guidelines which are enforced through social institutions to govern behavior, wherever possible.**
- ✓ **There are mainly three philosophical explanations of laws:**
  - **Utilitarian answer** —- law is command, backed by threat of sanctions, from a sovereign, to whom people have a habit of obedience;
  - Natural lawyers —- law reflects essentially moral and unchangeable of nature with justice; law arises from both a social impulse and reasons;
  - Law's positivism, which is totally contradictory to the natural ideas —- real law is entirely separate from morality and it emanates from the will to power.

What is ethics?

- ✓ Ethics is the philosophical study of morality while morality are the rules of conduct describing what people have to and have not to do in various situations.
- ✓ Ethics are the rational, systematic analysis of conduct that can cause benefit or harm to other people.
- ✓ Ethics stress on logic and reasons. Different people can have different opinions about one situation as long as there are reasonable logics.
- ✓ **The similarities between laws and ethics**
  - The standards of laws conform to people's ethical ideas to some degree.
- ✓ **The difference between laws and ethics:**
  - Ethics stress on the individual while laws stress on whole society.

- Ethics emphasize on logics and reasons while laws are based on the words.

3.4.4. Proper role of laws

Good laws, effectively enforced, clearly produce benefits. They authoritatively establish reasonable minimal standards of professional conduct and provide at least a self-interested motive for most people and corporations to fulfill. Further they serve as moral support and defense for the people who are willing to act ethically.

Thus, it is concluded that:

a. The rules which govern engineering practice should be construed as of responsible experimentation rather than rules of a game. This makes the engineer responsible for the safe conduct of the experiment.
b. Precise rules and sanctions are suitable in case of ethical misconduct that involves the violation of established engineering procedures, which are aimed at the safety and the welfare of the public.
c. In situations where the experimentation is large and time consuming, the rules must not try to cover all possible outcomes, and they should not compel the engineers to follow rigid courses of action.
d. The regulation should be broad, but make engineers accountable for their decisions, and
e. Through their professional societies, the engineers can facilitate framing the rules, amend wherever necessary, and enforce them, but without giving-in for conflicts of interest.

3.5. Industrial Standards

- ✓ **What is meant by standardization?**
  - **Standardization primarily means setting up standards or measuring sticks by which extent, quality, quantity, value performance or service may be gauged or determined**
  - **It is the process of defining and applying conditions required to ensure that a given range of requirements can be easily met with minimum changes in an economical and reproducible manner by the latest techniques**
- ✓ **What are standards?**
  - Standards are framed by companies for their in-house use i.e. Internal use and by professional associations and trade associations for industry wide use. Sometimes standards are also prescribed as parts of Laws and official regulations
- ✓ **Standard facilities**
  - Interchangeability
  - **Accuracy** in measurement
  - Ease of handling
  - Prevention of harms
  - Decreased production costs
  - Quality products

Table 4–1 Types of standards

Criterion	Purpose	Selected examples
Uniformity of physical properties and functions	Accuracy in measurement, interchangeability, ease of handling	Standards of weights, screw dimensions, standard time, film size
Safety and reliability	Preparation of injury, death, and loss of income or property	National Electric Code, boiler code, methods of handling toxic wastes
Quality of product	Fair value for price	Plywood grade, lamp life
Quality of personnel and service	Competence in carrying out tasks	Accreditation of schools, professional licenses
Use of accepted procedures	Sound design, ease of communications	Drawing symbols, test procedures
Separability	Freedom from interference	Highway lane markings, radio frequency bands
Quality procedures approved by ISO	Assurance of product acceptance in member countries	Quality of products, work, certificates, and degrees

- ✓ **Benefits of Standards**
  - Standards help the manufacturers, the client and the public.
  - They preserve some competitiveness in industry by reducing overemphasis on name brands and giving the smaller manufacturer a chance to compete.
  - They ensure a measure of quality and thus facilitate more realistic trade-off decisions.
  - International standards are becoming a necessity in European and world trade. The International Standards Organization (ISO) that replaces the detailed national specifications for a excess of products with statements of procedures that a manufacturer guarantees to carry out to assure quality products.
- ✓ **Limitations of Standards**
  - Standards have been a hindrance at times. For many years they were mostly descriptive, specifying, for instance, how many joists of what size should support a given type of floor?
  - The move to performance standards, which in the case of a floor may specify only the required load-bearing capacity, has alleviated that problem somewhat.
  - But other difficulties can arise when special interests (e.g., manufacturers, trade unions, exporters, and importers) manage to impose unnecessary provisions on standards or remove important provisions from them to secure their own narrow self-interest.
  - Requiring metal conduits for home wiring is one example of this problem. Modern conductor coverings have eliminated the need for metal conduit in many applications, but many localities still require it. Its use sells more conduit and labor time for installation.
  - But standards did not foresee the dangers encountered when aluminum was substituted for copper as conductor in home wiring, as happened in the United States during the copper scarcity occasioned by the Vietnam War. Until better ways were

devised for fastening aluminum conductors, many fires occurred because of the gradual loosening of screw terminals.

3.6. CASE STUDY: THE CHALLENGER

The world has known about much number of accidents. Among them, the explosion of the space shuttle **Challenger** is one of the most familiar ones. Back then, this case had been reviewed vigorously by media coverage, government reports and transcripts of hearings. This case deals with many ethical issues which engineers faced.

It poses many questions before us. A few questions are listed below –

1. What is the exact role of the engineer when safety issues are concerned?
2. Who should have the ultimate authority for decision making to order for a launch?
3. Whether the ordering of a launch be an engineering or a managerial decision?

- ✓ Challenger space shuttle mainly consisted of an orbiter, two solid propellant boosters and a single liquid-propeller booster, which was actually designed to be a reusable one. All the boosters were ignited and the orbiter took a lift-off from the earth. But the cold temperature caused trouble to the O-rings which were eroded.

The cause behind the challenger accident

- ✓ The accident took place on 28th January 1986, due to the failure of one of the solid boosters. In the design of the space shuttle, the main parts which needed careful design of the fields joints where the individual cylinders were placed together.
- ✓ The assembly mainly consists of tang and clevis joints which are sealed by two O-rings, whose function is to prevent the combustion gases of the solid propellant from escaping. The O-rings were eroded by hot gases, as these were made up of synthetic rubber. But this was not a serious problem, as the solid rocket boosters were only for reuse initially for the few minutes of the flight. If the erosion of the O-rings could be restrained from completely burning out then the design of the joint would be acceptable.
- ✓ In the post flight experiment in 1985, the Thiokol engineers noticed black soot and grease on the outside of the boosters due to the leakage of hot gases blown through the O-rings. This raised a doubt on the resiliency of the materials used for the O-rings. Thiokol engineers redesigned the rings with steel billets to withstand the hot gases. But unfortunately this new design was not ready by that time of flight in 1986.

Delay in launch

- ✓ The political conditions under which NASA operated are the main cause for unavoidable delay in the decision to be taken for the shuttle performance. The launching date had already been postponed for the availability of the then Vice President George Bush, the space NASA supporter. Later, the launch further got delayed due to a problem in micro switch in the hatch-locking mechanism. The cold weather problem and long discussions went on among the engineers. The number of teleconferences further delayed the previous testing in 1985 itself.
- ✓ The O-rings required temperature bearings of 53°F whereas the challenger had temperature bearings of only 29°F, which was far below the environment temperature at which NASA had the previous trail. This might not be matter of concern, as the revised final decision made with the available data then, was that there was no correlation between the temperature and the degree at which O-rings had eroded by the blow-by gas in the previous launch. Assuming a safety concern due to cold weather, though the data were not concluded satisfactorily, a decision was taken not to delay further for so many reasons, and the launch was finally recommended.

Unexpected Change

- ✓ But unexpectedly the overnight temperature at the time of launch was 8°F colder than ever experienced. It was estimated that the temperature of the right hand booster would be only at 28°F. The camera noticed a puff of smoke coming out from the field joints as soon as the boosters were ignited. But the O-rings were not positioned properly on their seats due to extreme cold temperature. The putty used as heat resistant material was also too cold that it failed to protect the O-rings. All these effects made the hot gases to burn past both the O- rings, leading to a blow-by over an arc around the O-rings.
- ✓ Though immediately further sealing was made by the by-products of combustion in the rocket propulsion, a glassy oxide formed on the joints. The oxides which were temporarily sealing the field joints at high temperature, later were shattered by the stresses caused by the wind. Again the joints were opened and the hot gases escaped from the solid boosters. But the boosters were attached to the large liquid fuel boosters as per the design. This made the flames due to blow-by from the solid fuel boosters quickly to burn through the external tank. This led to the ignition of the liquid propellant making the shuttle exploded.

- ✓ At 11.38 a.m. the rockets along with Challenger rose up the sky. The cameras recorded smoke coming out of one of the filed joints on the right booster rocket. Soon there was a flame that hit the external fuel tank. At 76 seconds into the flight, the Challenger at a height of 10 miles was totally engulfed in a fireball. The crew cabin fell into the ocean killing all the seven aboard.

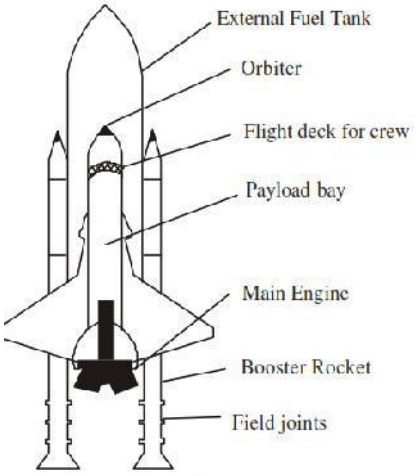


Fig. 3.2 a Challenger

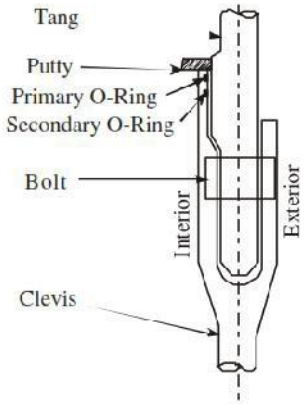


Fig. 3.2 b Field joint before ignition

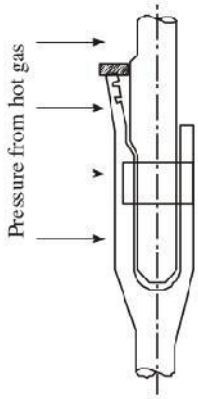


Fig. 3.2 c Field joint after ignition

- ✓ Some of the factual issues, conceptual issues and moral/normative issues in the space shuttle challenger incident, are highlighted hereunder for further study.

Moral/Normative Issues

- ✓ The crew had no escape mechanism. Douglas, the engineer, designed an abort module to allow the separation of the orbiter, triggered by a field-joint leak. But such a 'safe exit' was rejected as too expensive, and because of an accompanying reduction in payload.
- ✓ The crew were not informed of the problems existing in the field joints. The principle of informed consent was not followed.
- ✓ Engineers gave warning signals on safety. But the management group prevailed over and ignored the warning

Conceptual Issues

- ✓ NASA counted that the probability of failure of the craft was one in one lakh launches. But it was expected that only the 100000th launch will fail.
- ✓ There were 700 criticality-1 items, which included the field joints. A failure in any one of them would have caused the tragedy. No back-up or stand-bye had been provided for these criticality-1 components.

Factual/Descriptive Issues

- ✓ Field joints gave way in earlier flights. But the authorities felt the risk is not high.
- ✓ NASA has disregarded warnings about the bad weather, at the time of launch, because they wanted to complete the project, prove their supremacy, get the funding from Government continued and get an applaud from the President of USA.
- ✓ The inability of the Rockwell Engineers (manufacturer) to prove that the lift-off was unsafe. This was interpreted by the NASA, as an approval by Rockwell to launch.

Roger's Commission

- ✓ Later the accident was reviewed and investigations were carried out by the number of committees involved and by various government bodies. President Regan appointed a commission called the **Rogers Commission** which constituted of many distinguished scientists and engineers. The eminent scientists in the commission after thorough examination and investigations gave a report on the flexibility of the material and proved that the resiliency of the material was not sufficient and drastically reduced during the cold launch.
- ✓ After the hearings of the commission, Thiokol engineers and NASA investigated possible causes of the explosion, which led to a lot of arguments among the other officials that this investigating team is trying to look for other causes, which are not at all plausible. However, the debacle highlights how lack of responsibility and morality, improper functions, and lax performance of duties of the engineers resulted in the failure of the launch

3.7. Research ethics

3.7.1. What is research ethics?

Research that involves human subjects or participants raises unique and complex ethical, legal, social and political issues. Research ethics is specifically interested in the analysis of ethical issues that are raised when people are involved as participants in research. There are three objectives in research ethics. The first and broadest objective is to protect human participants. The second objective is to ensure that research is conducted in a way that serves interests of individuals, groups and/or society as a whole. Finally, the third objective is to examine specific research activities and projects for their ethical soundness, looking at issues such as the management of risk, protection of confidentiality and the process of informed consent.
Research ethicists everywhere today are challenged by issues that reflect global concerns in other domains, such as the conduct of research in developing countries, the limits of research involving genetic material and the protection of privacy in light of advances in technology and Internet capabilities.

3.7.2. Why research ethics?

- **To protect participants /patients /society /resources /researcher**
  - Protect from harm
  - Show respect -privacy /confidentiality -Informed consent
  - Refrain from Coercion and undue inducement
  - Refrain from indiscriminate use of resources
  - Ensure Favorable Risk-Benefit Ratio: risk should be minimized & potential benefit to society must outweigh risks
  - Must be of social value: improvement of health/knowledge for the benefit of society/science

- high social value: use of stem cells, to improve quality of life for Huntington's disease patients
- less social value: drug studies conducted to obtain data that allows a new drug to compete in the healthcare marketplace even though existing effective and often cheaper therapeutics are already available

- **To ensure accuracy of scientific knowledge**
  - Should be methodically rigorous - Scientific validity
  - Fair subject selection: with inclusion / exclusion criteria & a valid number of subjects in order to project results to the population
  - State research method clearly so that another person can conduct advanced study in future by using publication
  - Do not gloss research method
  - Should not falsify/modify/omit data
  - Use actual data for analysis/cannot include someone else's data
  - Report errors
  - Be aware of conflict of interest
  - Should not withhold and/or 'vaguing up' information
  - Keep data and material for 5 years
  - Data and material should be available to others
  - Do not present/publish paper from incomplete research or from anticipated outcomes
  - Should not duplicate publications and submissions
  - Avoid piecemeal publication
  - Should be reviewed Independently by unaffiliated individuals

- To protect intellectual and property rights
  - Citation and authorship inclusion-Writing and significant, scientific contribution, order-order of contribution
  - Whenever somebody else's work is quoted reference should be made to the original author (Piracy vs plagiarism)
  - Acknowledgement should include the names of person who helped

3.7.3. Codes and Policies for Research Ethics

Many government agencies, such as the National Institutes of Health (NIH), the National Science Foundation (NSF), the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA), and the US Department of Agriculture (USDA) have ethics rules for funded researchers.

Ethical principles that various codes address

- ✓ **Honesty**
  - Strive for honesty in all scientific communications. Honestly report data, results, methods and procedures, and publication status. Do not fabricate, falsify, or misrepresent data. Do not deceive colleagues, research sponsors, or the public.
- ✓ **Objectivity**

- Strive to avoid bias in experimental design, data analysis, data interpretation, peer review, personnel decisions, grant writing, expert testimony, and other aspects of research where objectivity is expected or required. Avoid or minimize bias or self-deception. Disclose personal or financial interests that may affect research.

✓ **Integrity**
- Keep your promises and agreements; act with sincerity; strive for consistency of thought and action.

✓ **Carefulness**
- Avoid careless errors and negligence; carefully and critically examine your own work and the work of your peers. Keep good records of research activities, such as data collection, research design, and correspondence with agencies or journals.

✓ **Openness**
- Share data, results, ideas, tools, resources. Be open to criticism and new ideas.

✓ **Respect for Intellectual Property**
- Honor patents, copyrights, and other forms of intellectual property. Do not use unpublished data, methods, or results without permission. Give proper acknowledgement or credit for all contributions to research. Never plagiarize.

✓ **Confidentiality**
- Protect confidential communications, such as papers or grants submitted for publication, personnel records, trade or military secrets, and patient records.

✓ **Responsible Publication**
- Publish in order to advance research and scholarship, not to advance just your own career. Avoid wasteful and duplicative publication.

✓ **Responsible Mentoring**
- Help to educate, mentor, and advise students. Promote their welfare and allow them to make their own decisions.

✓ **Respect for colleagues**
- Respect your colleagues and treat them fairly.

✓ **Social Responsibility**
- Strive to promote social good and prevent or mitigate social harms through research, public education, and advocacy.

✓ **Non-Discrimination**
- Avoid discrimination against colleagues or students on the basis of sex, race, ethnicity, or other factors not related to scientific competence and integrity.

✓ **Competence**

✓ Maintain and improve your own professional competence and expertise through lifelong education and learning; take steps to promote competence in science as a whole.

✓ **Legality**
- Know and obey relevant laws and institutional and governmental policies.

✓ **Animal Care**
- Show proper respect and care for animals when using them in research. Do not conduct unnecessary or poorly designed animal experiments.

✓ **Human Subjects Protection**

- When conducting research on human subjects, minimize harms and risks and maximize benefits; respect human dignity, privacy, and autonomy; take special precautions with vulnerable populations; and strive to distribute the benefits and burdens of research fairly.

3.8. Examples:

Case 1: The research protocol for a study of a drug on hypertension requires the administration of the drug at different doses to 50 laboratory mice, with chemical and behavioral tests to determine toxic effects. Tom has almost finished the experiment for Dr. Q. He has only 5 mice left to test. However, he really wants to finish his work in time to go to Florida on spring break with his friends, who are leaving tonight. He has injected the drug in all 50 mice but has not completed all of the tests. He therefore decides to extrapolate from the 45 completed results to produce the 5 additional results.

Many different research ethics policies would hold that Tom has acted unethically by fabricating data. If this study were sponsored by a federal agency, such as the NIH, his actions would constitute a form of **research misconduct**, which the government defines as "fabrication, falsification, or plagiarism" (or FFP). Actions that nearly all researchers classify as unethical are viewed as misconduct. It is important to remember, however, that misconduct occurs only when researchers **intend to deceive**: honest errors related to sloppiness, poor record keeping, miscalculations, bias, self-deception, and even negligence do not constitute misconduct.

Case 2: Dr. T has just discovered a mathematical error in his paper that has been accepted for publication in a journal. The error does not affect the overall results of his research, but it is potentially misleading. The journal has just gone to press, so it is too late to catch the error before it appears in print. In order to avoid embarrassment, Dr. T decides to ignore the error.

Dr. T's error is not misconduct nor is his decision to take no action to correct the error. Most researchers, as well as many different policies and codes would say that Dr. T should tell the journal (and any coauthors) about the error and consider publishing a correction or errata. Failing to publish a correction would be unethical because it would violate norms relating to honesty and objectivity in research.

There are many other activities that the government does not define as "misconduct" but which are still regarded by most researchers as unethical. These are sometimes referred to as "other deviations" from acceptable research practices and include:

- Publishing the same paper in two different journals without telling the editors
- Submitting the same paper to different journals without telling the editors
- Not informing a collaborator of your intent to file a patent in order to make sure that you are the sole inventor
- Including a colleague as an author on a paper in return for a favor even though the colleague did not make a serious contribution to the paper
- Discussing with your colleagues confidential data from a paper that you are reviewing for a journal
- Using data, ideas, or methods you learn about while reviewing a grant or a papers without permission
- Trimming outliers from a data set without discussing your reasons in paper
- Using an inappropriate statistical technique in order to enhance the significance of your research

- Bypassing the peer review process and announcing your results through a press conference without giving peers adequate information to review your work
- Conducting a review of the literature that fails to acknowledge the contributions of other people in the field or relevant prior work
- Stretching the truth on a grant application in order to convince reviewers that your project will make a significant contribution to the field
- Stretching the truth on a job application or curriculum vita
- Giving the same research project to two graduate students in order to see who can do it the fastest
- Overworking, neglecting, or exploiting graduate or post-doctoral students
- Failing to keep good research records
- Failing to maintain research data for a reasonable period of time
- Making derogatory comments and personal attacks in your review of author's submission
- Promising a student a better grade for sexual favors
- Using a racist epithet in the laboratory
- Making significant deviations from the research protocol approved by your institution's Animal Care and Use Committee or Institutional Review Board for Human Subjects Research without telling the committee or the board
- Not reporting an adverse event in a human research experiment
- Wasting animals in research
- Exposing students and staff to biological risks in violation of your institution's biosafety rules
- Sabotaging someone's work
- Stealing supplies, books, or data
- Rigging an experiment so you know how it will turn out
- Making unauthorized copies of data, papers, or computer programs
- Owning over $10,000 in stock in a company that sponsors your research and not disclosing this financial interest
- Deliberately overestimating the clinical significance of a new drug in order to obtain economic benefits

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

4.1.Safety and its concept

4.1.1. Definition

- **Safety means state of being safe, safe means protected from danger harm.**
- **The term safety is always difficult to describe completely, what may be safe for one person may be risk for another one.**
- **The *American Heritage Dictionary* safety as freedom from damage, injury, or risk.**
- The definition for safety is defined by William.W. Lowrence as follows:
  - **A thing is safe if its risks are judged to be acceptable.**

4.1.2. Drawbacks of the definition

- **Under estimation of risks:** An unsafe product may be considered to be safe because of faulty view and misjudgment of a person. Example :Buying Improperly designed coil type water heater, which eventually ends up with a severe electric shock.
- **Over estimation of risk:** A product, whose risks are comparatively less, may be considered unsafe because of over safety concern of a person. Example: Thinking that adding chlorine in drinking water will kill a lot of people. In this case, according to Lowrence's definition, the water became unsafe the moment we judged the risks are unacceptable for us
- **No estimation of risk :** For the person who does not judge about the risks, the product may be either safe or unsafe. Example: Purchasing a LPG gasoline fuel driven car without judging anything about its safely.

4.1.3. Modified Definition

- **"A thing is safe (to a certain degree) with respect to a given person or group at a given time, If its risks went fully known, if those risks would be judged acceptable (to that certain degree), In light of settled value principles". In** the modified Lowrance definition the term 'things' represent not only products, but also services, processes, etc. Therefore the definition can be extended to medicines, finance, International affairs, etc.

safety and risk are essentially subjective and depend on many factors:

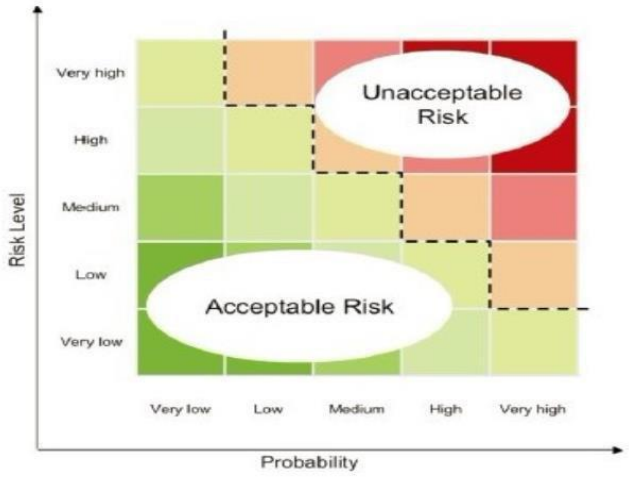
- ***Voluntary vs. involuntary risk***. **Many consider something safer if they knowingly take on the risk, but would find it unsafe if forced to do so.** Voluntary risks are considered as safe and the involuntary risks are considered as unsafe.
  - If the property values are low enough, some people will be tempted to buy a house near a plant that emits low levels of a toxic waste into the air. They are willing to assume the risk for the benefit of cheap housing.
  - However, if a person already living near a plant finds that toxic fumes are emitted by the plant and he wasn't informed, the risk will appear to be larger, since it was not voluntarily assumed. This principle is true even if the level of

emission is identical to that in the example of a person choosing to move near the plant.

- Voluntary risks have to do with lifestyle choices. They are the risks that people take knowing that they may have consequences. These risks include smoking tobacco, driving a car, skydiving, and climbing a ladder.
- Involuntary risks are risks that people take either not knowing that they are at risk, or they are unable to control the fact that they are at risk, such as secondhand smoke. These risks often include environmental hazards such as lightning, tsunamis, and tornadoes.

- ***Short-term vs. long-term consequences***. **Something that might cause a short-lived illness or disability seems safer than something that will result in permanent disability.** An activity for which there is a risk of getting a fractured leg will appear much less risky than an activity with a risk of a spinal fracture, since a broken leg will be painful and disabling for a few months, but generally full recovery is the norm. Spinal fractures, however, can lead to permanent disability.
- ***Expected probability***. **Many might find a one-in-a-million chance of a severe injury to be an acceptable risk, whereas a 50:50 chance of a fairly minor injury might be unacceptable**. Swimming at a beach where there is known to be a large concentration of jellyfish would be unacceptable to many, since there would be a high probability of a painful, though rarely fatal, sting. Yet, at the same beach, the risk of a shark attack is low enough that it doesn't deter anyone from swimming, even though such an attack would very likely lead to death or dismemberment. It is important to remember here that the expected probability is only an educated guess.
- ***Reversible effects***. **Something will seem less risky if the bad effects are ultimately reversible**.
- ***Threshold levels for risk***. **Something that is risky only at fairly high exposures will seem safer than something with a uniform exposure to risk.** For example, the probability of being in an automobile accident is the same regardless of how often you drive. In contrast, studies have shown that low levels of nuclear radiation actually have beneficial effects on human health, while only at higher levels of exposure are there severe health problems or death. If there is a threshold for the effects, generally there will be a greater tolerance for risk.
- ***Delayed vs. immediate risk***. **An activity whose harm is delayed for many years will seem much less risky than something with an immediate effect.** For example, for several years now, Americans have been warned about the adverse long term health effects of a high-fat diet. This type of diet can lead to chronic heart problems or stroke later in life. Yet, many ignore these warnings and are unconcerned about a risk that is so far in the future. These same people might find an activity such as sky diving unacceptably risky, since an accident will cause immediate injury or death.

Something that one person feels is safe may seem very unsafe to someone else. This creates some confusion for the engineer who has to decide whether a project is safe enough to be pursued. In making a decision, some analysis methods, especially line drawing and flow charting, can be used. Ultimately, it is up to the engineer and company management to use their professional judgment to determine whether a project can be safely implemented.



4.2.Engineers and Safety

4.2.1. Criteria to ensure safety design

- **The design must comply with the applicable laws**. This requirement should be easy to meet, since legal standards for product safety are generally well known, are published, and are easily accessible.
- **A design must meet the standard of "accepted engineering practice."** For example, federal safety laws might not require that the power supply in a home computer be made inaccessible to the consumer who opens up her computer. However, if most manufacturers have designed their supplies so that no potentially lethal voltages are accessible, then that standard should be followed by all designers, even if doing so increases the cost of the product.
- **Alternative designs that are potentially safer must be explored.** This requirement requires a fair amount of creativity in seeking alternative solutions. This creativity can involve discussing design strategies with others in your field and brainstorming new alternatives with them. The best way to know if your design is the safest available is to compare it to other potential designs.
- **The engineer must attempt to foresee potential misuses of the product by the consumer and must design to avoid these problems**. Again, this requires a fair amount of creativity and research. An engineer should execute designs in such a way as to protect even someone who misuses the product.
- **Once the product is designed, both prototypes and finished devices must be rigorously tested. T**his testing is not just to determine whether the product meets the specifications. It should also involve testing to see if the product is safe. The importance of adequate testing can be illustrated by the Kursk submarine disaster.
- **Case Study:**The Kursk was a Russian navy submarine that sank in August of 2000, killing everyone on board. The sinking has been attributed to an explosion in the torpedo room that ripped open a large hole in the hull. Many crew members of the *Kursk* survived the initial explosion, but died because they were unable to escape from the submarine, and no attempts at rescue by other ships were successful. The June 3, 2002, edition of *Time* reported that Russian naval engineers say that the *Kursk* was equipped with a rescue capsule designed to allow crew members to float

safely to the surface in an emergency. However, in the rush to get the submarine into service, this safety system was never tested. After the accident, some of the survivors attempted to rescue themselves by using this system, but it did not function properly. It is essential that in any engineering design, all safety systems be tested to ensure that they work as intended.

4.2.2. Designing for Safety

Wilcox [1990] summarized how safety should be incorporated into the engineering design process as follows:

- Define the problem. This step includes determining the needs and requirements and often involves determining the constraints.
- Generate several solutions. Multiple alternative designs are created.
- Analyze each solution to determine the pros and cons of each. This step involves determining the consequences of each design solution and determining whether it solves the problem.
- Test the solutions.
- Select the best solution.
- Implement the chosen solution.
    - In step 1, it is appropriate to include issues of safety in the product definition and specification.
    - In steps 2 through 5, engineers typically consider issues of how well the solution meets the specifications, how easy it will be to build, and how costly it will be. Safety and risk should also be criteria considered during each of these steps.
    - Safety is especially important in step 5, where the engineer attempts to assess all of the trade-offs required to obtain a successful final design. In assessing these trade-offs, it is important to remember that safety considerations should be paramount and should have relatively higher weight than other issues.
    - Minimizing risk is often easier said than done. For example, the design engineer often must deal in uncertainties. Many of the risks can only be expressed as probabilities and especially in a new and innovative design for which the interaction of risks will be unknown.
    - Risk is also increased by the rapid pace at which engineering designs must be carried out. The practical approach to minimizing risk in a design is a "go slow" approach, in which care is taken to ensure that all possibilities have been adequately explored and that testing has been sufficiently thorough.

4.3. Risk and its concepts

4.3.1. What is meant by Risk?

- **A risk is the potential something unwanted and harmful may occur**
- The American Heritage Dictionary defines **risk as the possibility of suffering harm or loss**
- **Risk is meaningfully used with the adverse effect of harm. The term harm may be defined as an invasion of person's freedom or well being**
- **The three most important types of well being are:**
    - **Physical well being:**
    - **Psychological well being**
    - **Economical well being**

- Mostly engineering risks comes under physical and economical well being. Like faulty design of a chemical plant can cause accidents and economic disaster
- **Effects of risk: it includes dangers of bodily harm , economic loss and environmental degradation**
- **Causes of risk: risks or harms are caused by delayed jobs completion , faulty product or system design and economically and environmentally injurious solutions to technological problems**

4.3.2. Risk defined

Safety was defined as the risk that is known and judged as acceptable. But, risk is a potential that something unwanted and harmful may occur. It is the result of an unsafe situation, sometimes unanticipated, during its use.

Probability of safety = 1 – Probability of risk

Risk = Probability of occurrence × Consequence in magnitude

4.4.Risk Analysis or Determination of Risk

1. Knowledge of risk:

1. To assess a risk, an engineer must first identify it. To identify a risk, an engineer must first know the information about the safety of standard products.
2. Though past experience and historical data provide good information about the safety of standard products, still it is insufficient to completely assess the risk of a product.
3. The past experience and historical data are inadequate to access the risk, because of the following reasons:
   a. The information is not freely shared among firms, and
   b. There are always new applications of old technology that makes the available information less useful.
   c. Therefore in order to access the risk, engineers and firms should share the information and knowledge about the safety of products freely

2. <u>Uncertainties in Assessment</u>

There are many positive uncertainties in determining the risk of a product/service.

1. Restricted access to knowledge on risk: Some organizations do not disclose the data, citing legal restrictions.
2. Uncertain behavior of materials: Test data supplied by the suppliers are only statistical. The individual parts may behave considerably (! 3 σ) different from the statistical mean obtained from the tests on random samples.

3. Uncertain and varying behavior of user environments such as physical shock, thermal shock, fatigue, creep, impulse and self-excited vibrations in components or structures due to winds, snow fall, and rains cause sudden failure of the whole structure. An error or wrong procedure during assembly or joining the components may cause additional stress leading to early failure.
4. The use or misuse of materials/products, remaining untracked, e.g., exposure to rain or snow or damp weather is likely to change the properties.
5. Newer applications of obsolete technologies, remaining unpublished,
6. Substitution of newer materials whose behavior are not disclosed, and
7. The unexpected and unintended outcomes of the product/project.

All these aspects make the estimation of risk complex and unreliable. Hence, the data are to be monitored continuously and risk estimation updated periodically.

3. Testing for safety

Once the product is designed both protypes and finished device must be thoroughly tested.

Different methods are available to determine the risk (testing for safety)

- Testing on the functions of the safety-system components.
- Destructive testing: In this approach, testing is done till the component fails. It is too expensive, but very realistic and useful.
- Prototype testing: In this approach, the testing is done on a proportional scale model with all vital components fixed in the system. Dimensional analysis could be used to project the results at the actual conditions.
- Simulation testing: With the help of computer, the simulations are done. The safe boundary may be obtained. The effects of some controlled input variables on the outcomes can be predicted in a better way.

4.4.1. Analytical Methods

Several analytical methods are adopted in testing for safety of a product/project.

A. Scenario Analysis

1. This is the most common method of analysis. Starting from an event, different consequences are studied. This is more a qualitative method.
2. For example, a disaster recovery plan, for an organization is discussed. When the probability and size of loss (indicating possibility and financial significance, respectively) are both high, risk exists. On the other hand, risk is not associated with very low probability of occurrence, or with losses that under any other circumstances would be considered "affordable". But there is a gray area between probability/loss combinations that are truly risky, and those that are not. This reflects the fact that the boundary between risky and non-risky events is fuzzy, not exact.
3. To assess the risk faced by the organization, the planner matches the probability and loss characteristics of various exposures to one's intuition of risk. This exposure analysis can be most effectively carried out using 'loss scenarios'. **A scenario is a synopsis of events or conditions leading to an accident and subsequent loss. Scenarios may be specified informally, in the form of narrative, or formally using diagrams and flow charts.**

Steps for Risk Assessment

- What can go wrong that could lead to an outcome of hazard exposure? (identification and characterization of risk)
- How likely is this to happen? (quantification of risk, likelihood, and magnitude)
- If it happens, what are the consequences? Scenarios are constructed and the ways and means of facing the consequences are designed

Examples:

Consider three loss scenarios facing the company which is transporting various cargoes, some hazardous. The three scenarios involve the legal liability arising from use of company vehicles on public roads. The probability/loss combinations associated with these scenarios are 0.1, 1, and 10.4% Scenario A represents an upset or overturn of a truck carrying dangerous cargoes in a populated area. It is further assumed that the spill leads to an explosion or release of toxic chemicals. Scenario B represents the company's liability for an accident involving bodily injury and property damage from relatively "ordinary" road hazards. No spill or disruption of cargoes is involved. Finally, Scenario C identifies a situation involving multiple simultaneous catastrophes to the company fleet.

Scenario A has a probability of occurrence of 0.001 and a loss potential of Rs. 50 million. It is deemed sufficiently "possible" and significant so as to be unequivocally classified as "risky". Scenario B, on the other hand, while more probable than A, involves losses that this firm considers "affordable". As such, it is rated not risky with confidence. Not so easy to classify is Scenario C While the probability of multiple catastrophes is not strictly zero, it is rare (10^{-6}, or one chance in a million). So, while the loss potential is great, the chance of occurrence is "virtually impossible". Scenario C, nonetheless, resides in that gray area of risk that results in considerable anxiety over its classification.

The steps for Scenario building may alternatively be detailed as follows:

1. Identify the hazard of interest
2. State the question to be investigated
3. Develop a planned scenario
4. Develop a scenario tree
5. Collect evidence to evaluate the nodes of the scenario tree
6. Quantify the number of scenario tree, and
7. Link the information generated by scenario analysis with empirical evidence.

Using the Scenario

The uses of scenario-based risk analysis are many and varied. The explicit analysis of scenarios may suggest ways of reducing or eliminating exposures through risk or loss-control activities. Risk or loss control actions have the effect of reducing probability and amount of risk or loss or both. Often, scenarios are posited on the basis that risk potential is as low as reasonably achievable (ALARA). This type of analysis recognizes that even under the best of risk control programs, accidents will happen.

As the cornerstone of planning, scenario-based risk analysis allows identification and prioritization of disaster potential. Knowing what can happen, and the risk involved, allows the analyst to make effective plans for safety in the event of disaster. By concentrating on risky scenarios, the disaster planner can tailor actions to exposures. This ensures the best allocation of resources at the time of crisis.

B. Failure mode and Effect analysis

1. In this method, various parts or components of the system and their modes (patterns, propagation and nature) of failure are studied. The cause of failure or the interrelationships between the components are not studied.
2. FMEA is one of the qualitative tools, which support proactive quality strategies. FMEA concept was introduced in 1960s by aerospace companies. Then the use of FMEA was extended to automobile industries and other types of industries, understanding the value of this approach.

3. Thus, FMEA is defined as a systematic tool to

1. Identify possible failure modes in the products/process,
   (b) To understand failure mechanism (process that leads to failure),

(c) Risk analysis, and
(d) Plan for action on elimination or reduction of failure modes.

A. STEPS TO CONDUCT FMEA

FMEA is a cross-functional team management. Throughout the product development cycles, changes and updates will be introduced to the product and process. These changes have to be reviewed because they can introduce new risks or failure modes. It is thus necessary to review and update changes.

1. Product/process and its function must be understood first. This is the most fundamental concept to be adopted in this methodology. This understanding helps the engineer to identify product/process function that fall with the intended and unintended users.
2. Block diagram of product/process is created and developed. The diagram shows the major components or process steps as blocks, identifies their relations namely, input, function and output of the design. The diagram shows logical relationship of components and establishes a structure for FMEA. The block diagram should always be included in the FMEA form.
3. Header on FMEA form is completed. FMEA form includes part/process name, model date, revision date, and responsibility.
4. The items/functions are listed logically in the FMEA form, based on the block diagram.
5. Then failure modes are identified. A failure mode is defined wherein a component, subsystem, system, and process could potentially fail to meet the design intent.
6. A failure mode in one component can cause failure in another. Each failure should be listed in technical terms. Listing should be done component- or process-wise.
7. Then the effects of each risk/failure mode are described. This is done as perceived by both internal and external customers. The examples of risk/failure effect may include injury to the user, environment, equipment, and degraded performance. Then a numerical ranking is assigned to each risk or failure. It depends upon the severity of the effect. Commonly, in the scale, No.1 is used to represent no effect and 10 to indicate very severe failure, affecting system of operation and user. By this, the failures can be prioritized and real critical risks can be addressed first.
8. Then the causes of each failure mode have to be identified. A cause is defined as a design weakness that results in a failure. The potential causes for each failure mode are identified. The potential causes, for example, may be improper torque or contamination or excessive loading or external vibration.

9. The probability factor indicating the frequency of occurrence is considered. A numerical weightage can be assigned to each cause depending upon the probability of occurrence. A standard scale is used, 1 indicating 'not likely'and 10 indicating 'inevitable'.
10. Design or Process mechanism has to be identified, which can prevent the cause of failure or detect failure, before it reaches customer. Accordingly, the team has to identify tests, analysis, monitoring and other techniques to detect the risk or failure. Previously undetected or unidentified failures may appear when a new product/process are introduced. Therefore, FMEA should be updated and the required plans for the elimination of risks or failures have to be drawn.
11. Assessment of detection rating is done by assigning a numerical weightage. Value 1 indicates design control will certainly detect the potential cause, 10 indicates design control will not detect the cause or mechanism. A normal scale of 1 – 10 is used.
12. Risk Priority Number (RPN) is calculated and reviewed.

$$RPN = Severity \times Probability \times Detection$$

It is used to prioritise failure modes and viewed as a relative measure of the design risk

13. Recommended actions are determined to address potential risks or failures with high RPN.
14. Revalidate each action by reassessing severity, probability and detection and review the revised RPN. Check any further action is needed. FMEA has to be updated as and when the design or process is modified or changed.

STAGES OF FMEA

The analysis can be executed in four stages as given below.

Stage 1: Identifying possibilities and defining the scope. It includes function, possible failure mode, causes and effects of failure mode and detection/prevention of failure mode.

Stage 2: Measuring the volume of risk involved from the failure modes identified. It includes the probability of cause and occurrence, severity of effect and effectiveness of control to prevent cause, assessment of RPN.

Stage 3: Classification of severity of effects and the solution for the causes of high risk. Based on RPN, it prioritizes work, indicates detailed action, and assigning responsibility and target completion time to the team.

Stage 4: Revalidation of the above procedure, after corrective and preventive actions are implemented. Check whether target data and work is met. Review RPN and decide if any further action is needed.

FMEA DOCUMENT

The top portion of document is called *header* and mainly used for tracking. Except the first column of work sheet, all other details remain the same. The header includes following:

1. *Model no.*: It includes name and identification number of system, sub-system or component in order to avoid confusion between similar components.
2. *Prepared by*: The details like name, telephone number, address of the personnel should be included in the space for clarification, if any.

- Responsibility: The team incharge of design or process should be included. It also includes the company or department of the person or group responsible for

preparing the document. It is a common work sheet that can be used both for design FMEA and process FMEA. In design FMEA, following points are to be entered: name and number of item, listing the functions of the item (system or sub-system or component-wise), Environment in which system operates. In process FMEA, descriptions of processes, listing of processes and complete purpose of processes have to be entered.

- FMEA team: The names of responsible individuals and departments that have authority to perform task are included.
- FMEA date: The date of original FMEA compiled should be entered. In revision column latest revision date is entered.

Table 4.1 Worksheet for Design/Process FMEA

Model no.: *FMEA team members*					*Prepared by:* *Original FMEA date:*					*Responsibility:* *Date of revision:*					
Design/ Product	Potential cause failure	Potential effects of failure	Seerity	Class	Potential cause/ Mechanism of failure	Occurrence	Current process control	Detection	RPN	Recommended actions	Responsibility & target date	Action results			
												SEVERITY	OCCURRENCE	DETECTION	RPN

C. **Fault-tree Analysis**

- This is a qualitative method and was originated by Bell Telephones. It is technology-based deductive logic. The failure (undesirable event) is initially defined, and the events (causal relationships) leading to that failure are identified at different components level. This method can combine hardware failures and human failures

Example 1: Consider the failure of the steam flow in a thermal station. The water is pumped from a big reservoir nearby. The details are shown in Fig. 4.1

The common mode event in this case is an earthquake. This quake has affected many systems or components at the same time. Hence, we can call the 'earthquake' as the common mode/cause.

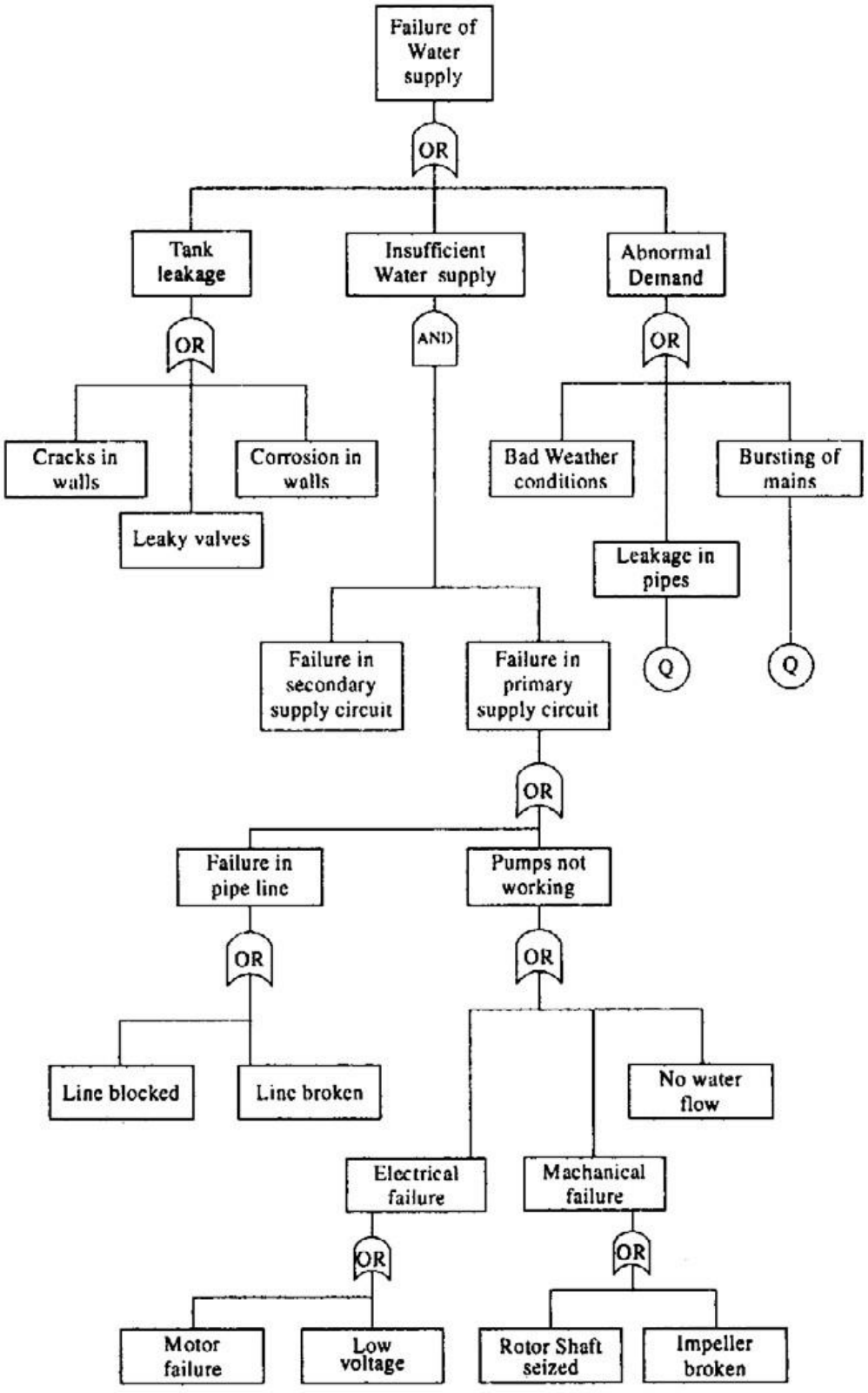
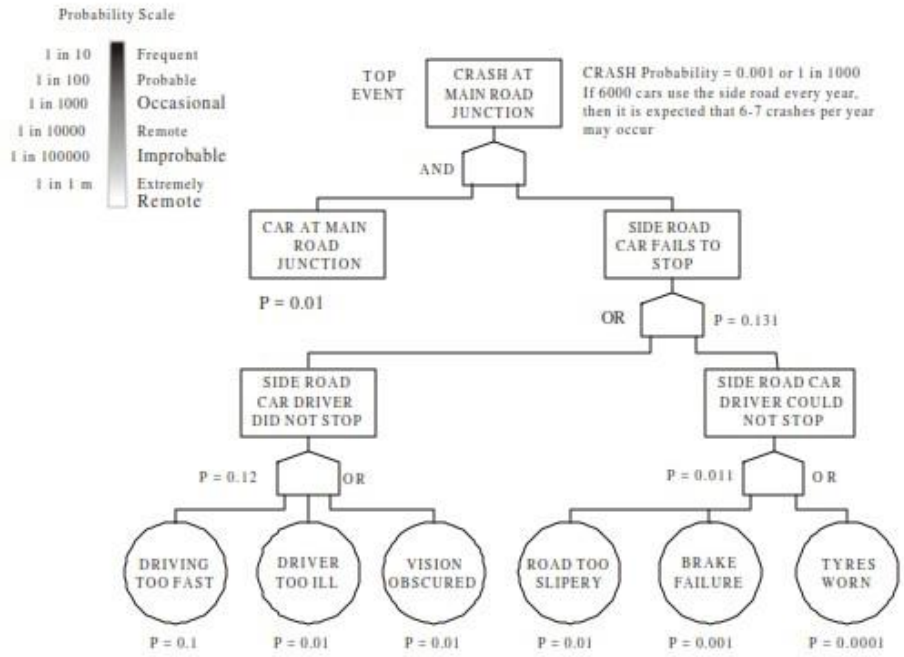


Fig. 4.1 Fault-tree analysis

Example 2: A crash at main road junction

The details of this Fault-tree Analysis are shown in Fig. 4.2

- Consider the probability of the crash at a road junction and construct a tree with and AND or GATE logic. The tree is constructed by deducing in turn the pre-conditions for the final event and then successively for the next levels of events, until the basic causes are identified.
- By ascribing probabilities to each event, the probability of a top event can be calculated. This requires knowledge of probable failure rates. At an OR gate, the probabilities must be added to give the probability of the next event, whereas at an AND gate, the probabilities are multiplied. This is a powerful technique for identifying the failures that have the greatest influence on bringing about the end event.



Example 3: An automobile car does not start.

The details of this case are shown in Fig. 4.3.

4. The advantages of FTA are (a) the primary cause can be located easily, and (b) It is useful in emergent situations i.e., a fire-fighting approach.

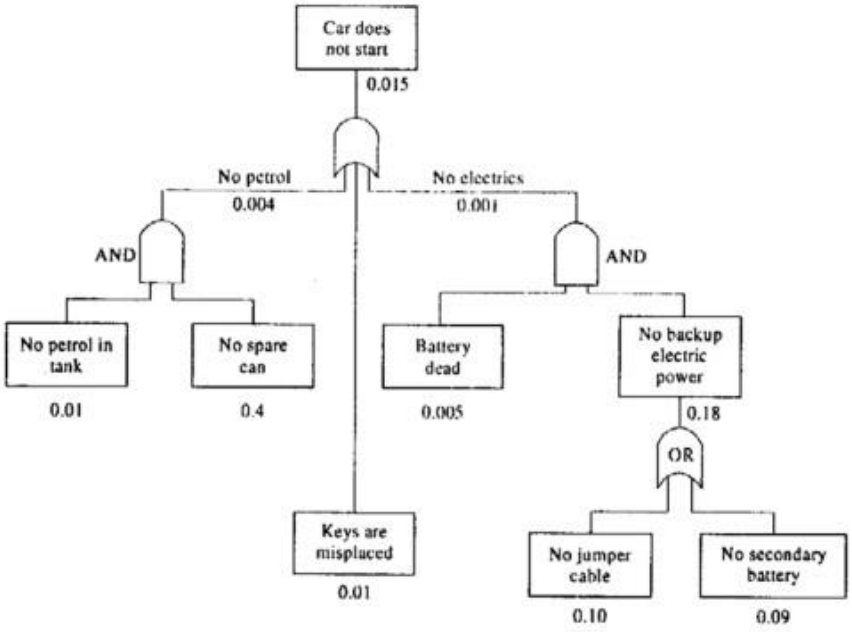


Fig. 4.3 Fault-tree analysis

4. Event-tree Analysis

This method illustrates the sequence of outcomes which may arise after the occurrence of a selected initial event. This method uses inductive logic. It is mainly used for consequence analysis and in identifying the potential hazardous existing situation in the system. It is the inverse of the FTA. FTA allows one to proceed back in time from possible catastrophic accidents to examine the components of sequences with probability of failure. But, the ETA allows the observer to proceed forward in time from potential component failures to final accident.

The most serious outcome such as explosion, toxic release, etc. is selected as the final event. A tree is then constructed by relating the sequences of events, which individually or in combination, could lead to the final event.

Example: Going late for duty

The events are listed, arranged chronologically, and in separate clusters, to include only that are relevant and important. Fig. 4.4 shows the ETA for the event of going late to the office as a simple illustrative example. The branching structure starts with the initiating event (initiator) on the left hand side of the tree and lead to a bad end event (final damaged state) shown at the far right side. The sequence starts with the person getting up late and being time pressed to get to duty.

The person has three alternatives to get there, namely, (*a*) driving his own car along the highway, that is subject to periodic overcrowding and delays while driving, (*b*) to use the public transport (express train or bus), and (*c*) call a coileague and share the car.

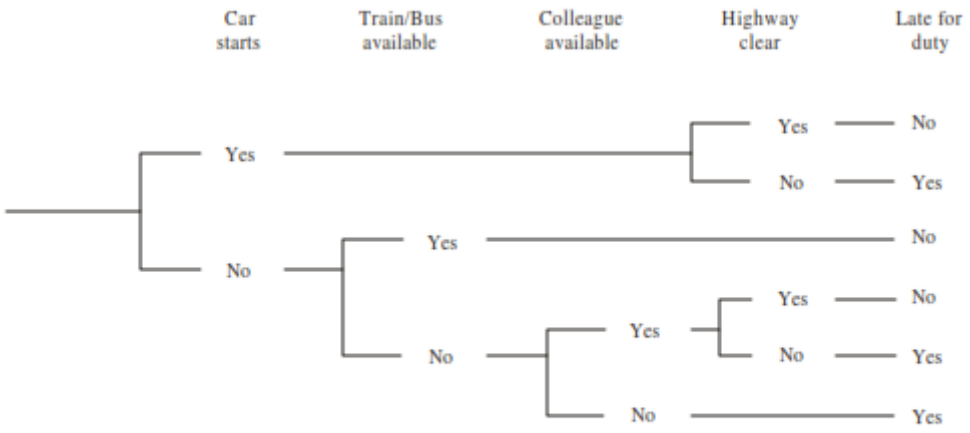


Fig. 4.4 Event-tree analysis

5. The figure shows the event-tree including the alternatives and different things that could lead to the employee being 'late again'.
6. Alternative outcomes are shown under each column.
7. Trace back from the outcomes towards the left hand side of the tree along horizontal paths. There are series of vertical branches labeled, Yes or No, which are connected to previous paths. The vertical branches represent the response (Yes/No) to the question (or the systems responsible) that appear on the top of the tree.
8. Tracing back from first 'No' under 'Late again' one comes to the first label Y/N: Is the highway clear? The up branch represents 'Yes' showing that the highway that morning was clear. The person arrived on time for duty. The down branch representing 'No' means that the highway was not clear and the person was late. This branch is attached to the earlier path and representing the condition that the car did not start. The up branch corresponding to question 'car starts?' indicates 'Yes'. Because car did start, there is no need to consider the backup alternatives of the colleague.
9. What are the possible outcomes, if the car does not start? Work from left to right starting on the lower "no'' branch for the question 'car starts?'. The next question is train/express bus available? The 'Yes' path goes straight to the outcome of not being late. Notice the questions in the event tree are very simple. We may even ask, is the train sufficiently frequent and are the terminals conveniently located to go to the office in time? Is the day analyzed a holiday with reduced trips? Has there been an accident or breakdown that day, on the line in question?
10. If the answer is 'No', then we are left with the 'colleague' option, and if he is available and is he willing to offer the ride in time. If not, he will be late. If 'Yes', the question 'Is the highway clear?' must be considered. Heavy highway traffic (Monday morning) may still cause a late arrival.

Conclusions

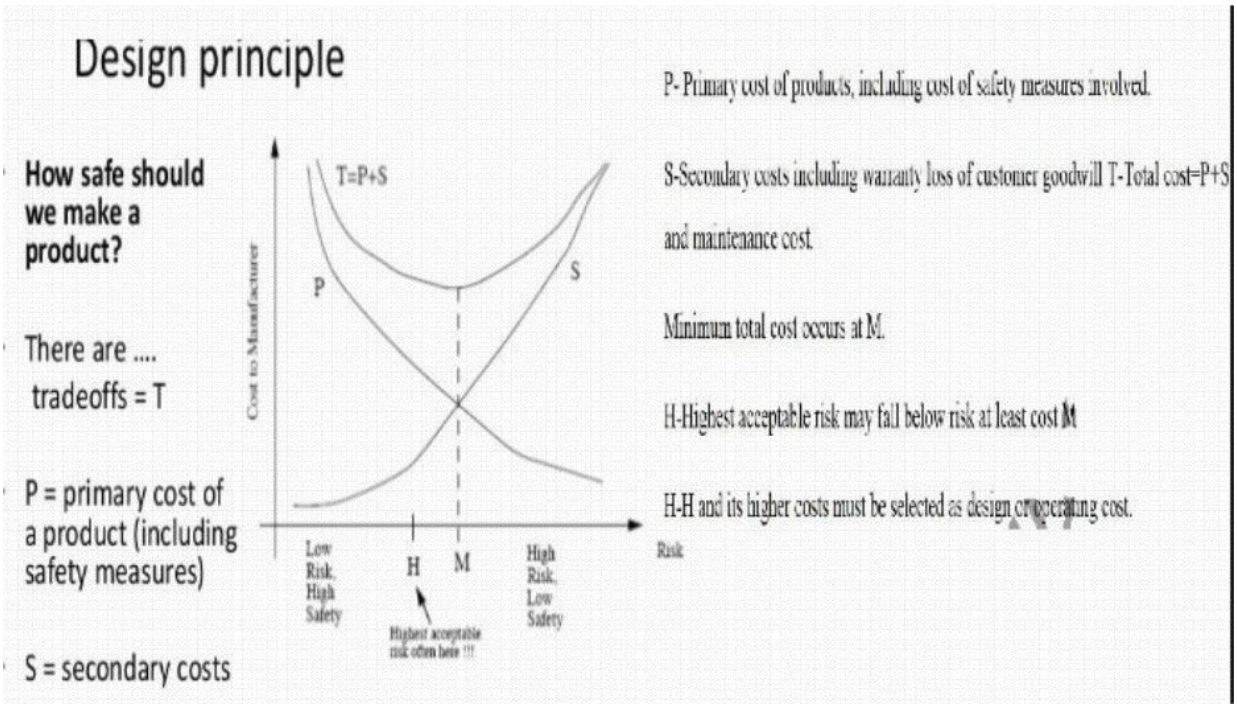
ETA is a variant of FTA that can be used to explore both success and failure alternatives at each level. Event trees are meant to show the path by which we get there. Hence, the event trees are said to have the memory**. The event tree is in a logical structure from left to right uses only OR gate. A fault tree is organized from Top to bottom hierarchy and uses both AND and OR gates. When there is more AND gates, then the tree contains more fault tolerant or safer and if it is more OR gates, it indicates a failure-prone system**

Human Error

The human-error contribution to overall system failure can be included in a FTA or ETA, if human-error probabilities are described in the same terms as component and hardware failures. To include human error, a detailed task analysis is first required, listing the actions to be done, conditions, speed of operation and the correct sequencing of individual actions. After allowing for deviations and shaping factors, which influence individual performance (such as skill and stress), and recovery factors (most human errors are recoverable), the contribution of human error can be estimated, by using data on human error rates.

4.4.2. Cost Analysis

A quantitative risk analysis is made on (1) primary costs: the loss of human lives, or property (assets), crops, and natural resources are estimated, and (2) secondary costs: the loss of human capability or loss of earning capacity, cost of treatment and rehabilitation, damage to the property, fertility to the soil, salinity to the groundwater etc. are estimated.



- A **stress on low risk and high safety leads to high primarily costs and lower secondary cost and vice versa**
- Total cost -= primary cost + secondary cost

4.5. Acceptability of Risk

4.5.1. What is meant by acceptable risk?

According to D.Rowe " a risk is acceptable when those affected are generally no longer apprehensive (fearful) about it

Apprehensiveness or doubtfulness mainly depends on how the risk is perceived by the people

4.5.2. Elements of Risk perception

The elements of risk perception are influenced by following factors:

- Whether the risk is assumed voluntarily
- The effect of knowledge on how the probabilities of harm are perceived
- Job related or other pressures that cause people to be aware of risks
- Whether the effect of risky activities or situations are immediately noticeable and
- Whether the potential victims are identified beforehand

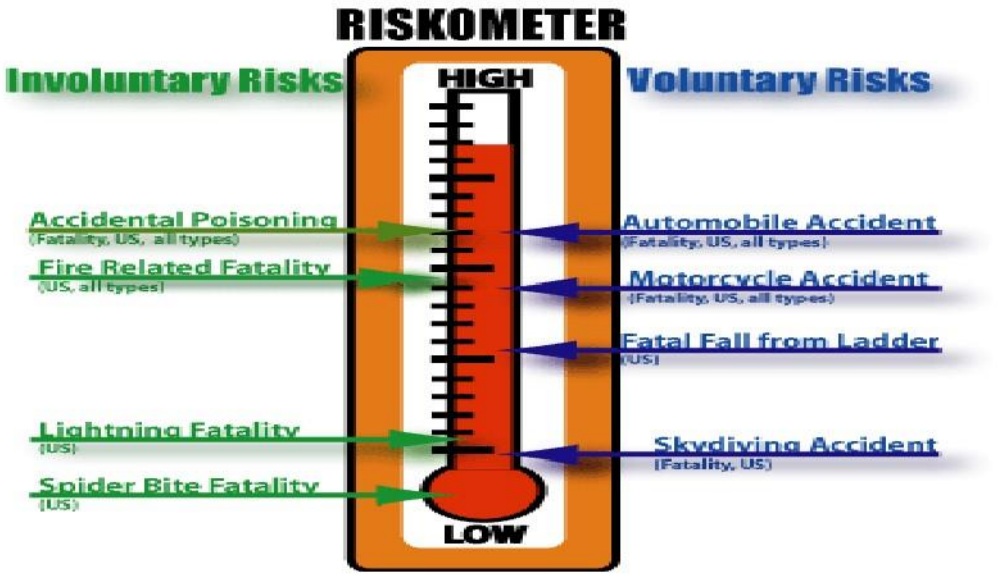
1. Voluntarism and control

Voluntary risk: If prople take risk knowingly, then their involvement of risk is know as voluntary risk

- A new friend lives near the cement plant, as they are unable to choose a better location for their house. The group work as motor mechanics in an automobile service station nearby.
- The air is full of dust and some drainage canals cut across their house sites. They hold that they are exposed to involuntary risk, from dust and drain. But the same persons have previously-owned motor cycles, with which they travel during weekends to their villages through muddy roads.
- Now they are willing to take risk voluntarily, i.e., they have no apprehensions on this travel. Statistical study indicates that individuals are more ready to accept voluntary risks (hunting, skiing, fighting in wars) than the involuntary risks (electric shock, natural calamity). Even though the voluntary risks are thousand times more fatal than involuntary ones, individuals meet them, for the thrill or adrenal quest or for achievement and for a page in the Guinness record.

Controlled risk: If the risk taken is within the control limit, which can be controlled by nay means, then the risk is known as controlled risk

- Another stand or perception closely related to this example is that of 'Control'. There are people who choose to play stunts such as jumping through fire gates, skiing and flying, car racing through tortuous terrains. Most of these people exhibit extraordinary confidence in them and on their gadgets and also believe that the hazards are under their control.



2. **Effects of information on risk assessment**
   - **The** information about harm and or danger should be presented in a systematic and appropriate manner. Because this helps in making proper decision making and has a great influence on how risks are perceived
   - The threshold limit of individuals for information varies from person to person. Some will be comfortable only when they have information of deeper depth and quality , while some may be comfortable with minimum information
3. **Job related risks**
   a. The exposure of risk depends on the person's job and his work place
   b. The nature of job and the working environment will determine the risk level of a person. People working in coal mines, oil mines, shipyards, chemical plants, nuclear power plant etc., have more probability of being exposed to higher risk
   c. Unions and occupational and safety regulations should regulate and enforce the employers to facilitate the standard working environment
   d. Engineers who design and equip workstations must take safety issues and workers suggestion regarding the work place
4. **Magnitude and proximity**

   4.1.1.1.1. Our reaction to risk is affected by the magnification and the potential identification or relationship we have within victims

   4.1.1.1.2. Thus the magnitude of risk and the proximity with the victims gratly influence the degree of reaction to the risk

4.6.Safe Exit

The 'safe exit' principles referred to as 'safe exit' are:

1. The product, when it fails, should fail safely
2. The product, when it fails, can be abandoned safely (it does not harm others by explosion or radiation)
3. The user can safely escape the product (e.g., ships need sufficient number of life

boats for all passengers and crew; multi-storeyed buildings need usable fire escapes)

4.7. Risk – Benefit analysis

4.7.1. Risk –Benefit value Function

1. The risk and benefits are based on the perceptions of probable gain and probable loss
2. A typical risk benefit value function is shown here
3. Here the risk benefit value function drops sharply on the loss portion that it raises on the gain portion
4. The threshold is added on both gain and loss sides of the function
5. The threshold on the loss side is to account human habit of ignoring smaller risk in order to avoid anxiety overload.
6. The threshold on the gain side is to account normal human inertia. It means inherent character of people may delay the process of seeking their own gain

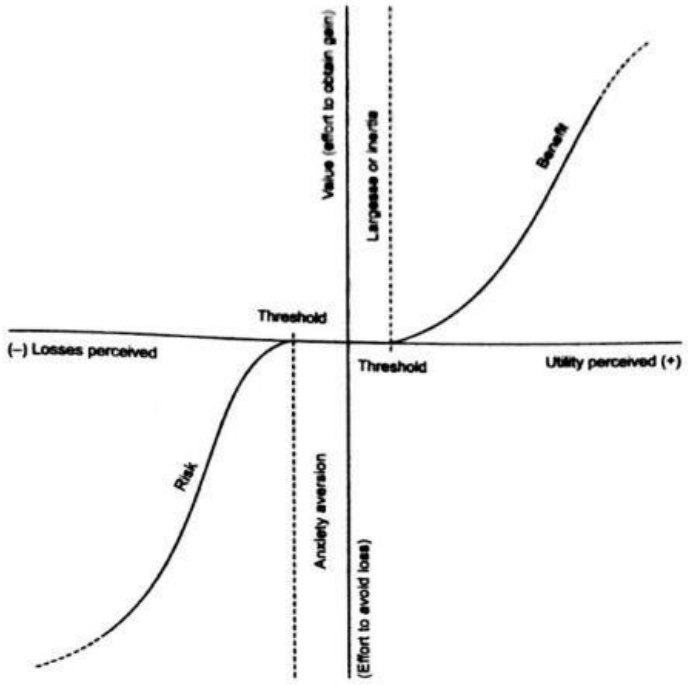


Fig. 4.1. Risk-benefit value function

4.7.2. What is risk benefit analysis?

- **Risk benefit analysis is similar to cost benefit analysis used to analyze the risk in a project and to determine whether the project should be carried out or not**
- **The major reasons for the analysis of the risk benefit are:**
  .1. To know risks and benefits and weigh them each
  .2. To decide on designs, advisability of product/project
  .3. To suggest and modify the design so that the risks are eliminated or reduced
- **There are some limitations that exist in the risk-benefit analysis. The economic and ethical limitations are presented as follows:**
- **Conceptual difficulties in Risk-benefit Analysis**
  - Primarily the benefits may go to one group and risks may go to another group. Is it ethically correct?

- Is an individual or government empowered to impose a risk on someone else on behalf of supposed benefit to somebody else? Sometimes, people who are exposed to maximum risks may get only the minimum benefits. In such cases, there is even violation of rights.
- The units for comparison are not the same, e.g., commissioning the express highways may add a few highway deaths versus faster and comfortable travel for several commuters. The benefits may be in terms of fuel, money and time saved, but lives of human being sacrificed.
- How do we then compare properly?
- Both risks and benefits lie in the future. The quantitative estimation of the future benefits, using the discounted present value (which may fluctuate), may not be correct and sometime misleading.
- Both risk and benefits have uncertainties. The estimated probability may differ frm region to region and time to time

- **Ethical implications of risk benefit analysis**
  - While performing the risk-benefit analysis. one should keep in mind the following ethical questions:
  - Under what conditions. Someone in Society is entitled to impose a risk on someone else on behalf of a supposed benefit to others?
  - How can we consider the worst-case scenarios of persons exposed to maximum risks white they are also obtaining only minimum benefits? Are their rights violated? Are they provided safer alternatives?

RISK BENEFIT ASSESSMENT-Example

ACTIVITY	How will young people BENEFIT from this	Possible hazards	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk RATING: L/M/H
POND DIPPING: Slippery pond decking	The decking allows close access to the contents of the pond and is an essential component of exploring this habitat.	Slips, trips and falls. Cuts, grazes and abrasions. Drowning (die through submersion in and inhalation of water).	Young people; adults	• Banks shallow and planted to prevent accidental entry. • No access to banks for young people; use decking or 'beach' area only. • Deepest area is centre of pond– keep to edges. • Dipping platform kept clear of trip hazards (e.g. nets, trays) • Pond use rules clearly displayed and reviewed at the start of each session.	Low

4.7.3. Personal Risk

Assessing the involuntary personal risk is not an easy task. For example, a group residing near the cement plant is exposed to a lot of risk. If suppose a cement plant or refinery was to come up in the area where this group already reside, they will object the proposal. The adequacy of compensation amount payable can not be fixed reasonably. How to estimate the rupee value of an individual human being? For example, a person may be a father to his young ones, husband to his beloved wife, son to his aged parents, friend to the needy, and as well a guardian for his pet dogs.

There are persons who dared to serve people in dire straits, in spite of the risky situations where their lives were in stakes. For example, Mahathma Gandhi served people during Navakali yatra, when dangers were present all over. For such saviors, there was no personal risk.

However, any of the following methodologies may be adopted to assess quantitatively, the personal risk:

1. Assess the voluntary activities (e.g., life insurance policy taken)
2. Assess the degree of occupational hazard (e.g., dust, radiation, and asbestosis) and its effect on health.
3. Loss of senses such as sight (eyes), hearing (ears) and loss of limbs (immobility by the loss/ damage to organs or disfigurement of the limbs or body).
4. Loss of earning capability, especially due to physical disability, and
5. Get assistance by trained arbiters.

4.7.4. Public risk

Assessing the public risk is relatively easy, as in the societal value system the cost of disability can be averaged out. For example, the U.S. National Safety Council 1 adopts an equivalent of 6000 days (16.42 years), for death, as per the personal value system for social costs of disability.

To assess the public risk, the loss on the assets and the correction costs are estimated. For example,

1 Loss of or reduction in future income or earning capacity due to loss of limbs or their capability
2 Costs associated with accident , which includes the transplantation or reinforcement of body parts/limbs, and medical treatment and
3 Cost of welfare, which includes rehabilitation, provision of less-demanding alternate jobs, and other disability benefits.

Example-Nuclear Reactor Risk Assessment

ACTIVITY	How will people BENEFIT from this?	Possible hazards	Who is at risk?	PRECAUTIONS in place to reduce the risk of injury	Overall risk RATING: L/M/H
Nuclear Power Plant	Produces electricity.	•Radioactive Waste Disposal •Environmental Impact. •Nuclear Accidents •High cost •Can explode anytime.	•People •Environment •Nature	• Use with proper training	High

4.7.5. Accounting publically for benefits and risks

Public accountability for risk has been affected by the following problem:

- An expert group cannot be expected to know everything. Hence the public processes are designed to establish safeguards and regulations
- The uncertainty produced by scientists and regulators who assure the public that there is no risk.
- The conceptions of risk vary depending on how the facts are presented. Hence cautions should be taken when stating the probabilities of rare events

4.7.6. Becoming a responsible Engineer regarding risk

(Role of engineers to safeguard the Public from Risk)

- The engineers can provide background material to prove the faulty positions.
- Engineers should actively participate in the debates related to safety and risk .

- Engineers should always insist on meaningful numbers and figures when assessing safety and risk.
- Engineers should also recognize the previously mentioned difficulties with measuring risks and benefits in absolute terms.
- Engineers should not be influenced by any influential lobby or trade organization.
- Engineers need to be sensitive to various qualitative value judgments related with human and ethical values .
- Engineers should be aware at the legal liabilities regarding risk.

4.8.Accidents

- There have been numerous studies of accidents and their causes, with attempts to categorize different types of accidents. The goal of this type of work is to understand the nature of accidents and therefore find ways to try to prevent them. Since the engineer's most important job is to protect the safety of the public, the results of this type of research have an impact on the engineering professional.
- One method is to group accidents into three types: procedural, engineered, and systemic
- **Procedural accidents** are perhaps the most common and are the result of someone making a bad choice or not following established procedures.
  - For example, in the airline industry, procedural accidents are frequently labeled as "pilot error." These are accidents caused by the misreading of an important gauge, flying when the weather should have dictated otherwise, or failure to follow regulations and procedures. In the airline industry, this type of error is not restricted to the pilot; it can also be committed by air-traffic controllers and maintenance personnel.
  - Engineers must also guard against procedural problems that can lead to accidents. These problems can include failure to adequately examine drawings before signing off on them, failure to follow design rules, or failure to design according to accepted engineering practice.
  - Procedural accidents are fairly well understood and are amenable to solution through increased training, more supervision, new laws or regulations, or closer scrutiny by regulators.
- **Engineered accidents** are caused by flaws in the design. These are failures of materials, devices that don't perform as expected, or devices that don't perform well under all circumstances encountered.
  - For example, micro cracks sometimes develop in turbine blades in aircraft engines. When these cracks become severe enough, the blade can fail and break apart. Sometimes, this has resulted in the penetration of the cabin by metal fragments, causing injury to passengers.
  - Engineered failures should be anticipated in the design stage and should be caught and corrected during testing. However, it isn't always possible to anticipate every condition that will be encountered, and sometimes testing doesn't occur over the entire range of possible operating conditions.
  - These types of accidents can be understood and alleviated as more knowledge is gained through testing and actual experience in the field.

- **Systemic accidents** are harder to understand and harder to control. They are characteristic of very complex technologies and the complex organizations that are required to operate them.
  - A perfect example of this phenomenon is the airline industry. Modern aircraft are very complicated systems. Running them properly requires the work of many individuals, including baggage handlers, mechanics, flight attendants, pilots, government regulators and inspectors, and air-traffic controllers. At many stages in the operation of an airline, there are chances for mistakes to occur, some with serious consequences. Often, a single, minor mistake isn't signicant, but a series of minor mistakes can add up to a disaster.
  - These small errors came together to cause a major accident.
  - The airline industry is not the only complex engineered system in our society that is susceptible to systemic accidents. Both modern military systems, especially nuclear weapons, for which complicated detection and communication systems are relied on for control, and nuclear power plants with complicated control and safety systems, have documented failures in the past that can be attributed to this type of systemic problem. systemic problem.

4.9. Reducing risk

Several techniques adopted to reduce the risks (or improve safety) in a product or process are listed as follows:

1. Application of inherent safety concepts in design, e.g., LPG cylinder is provided with frame to protect the valve while handling and facilitate cryogenic storage. A magnetic door catch provides an easy escape for children caught inside the 'fridge' accidentally.
2. Use of redundancy principle in the instrument protection/design. For example, use of stand-bye device, and back-up for computer storage.

3. Periodical monitoring (inspection) and testing of safety system to ensure reliability, e.g., fire extinguishers, 'earth' system in electric circuits are checked periodically.

4. Issue of operation manuals, training of the operating personnel and regular audits are adopted to ensure that the procedures are understood, followed and the systems are kept in working condition.

5. Development of well-designed emergency evacuation plan and regular rehearsal/drills to ensure preparedness, in case of emergency**.**

- **Risk management may be** defined as the eradication or minimization of the adverse effects of the pure risks to which an organization is exposed
- **Elements of risk management are:**
  - **Risk identification :** Risk can be identified by various techniques such as physical inspection , safety audit, job safety analysis and workers discussion and also historical data analysis
  - **Risk evaluation:** Risk can be measured on the basis of economic, social and legal considerations.
    - Economic and social considerations include financial aspects, uninsured cost of accidents, insurance premium, overall effect on the profitability, and possible lost of production.

- Legal considerations include possible constraint from compliance with health and safety legislation, code of practice, guidance notes and accepted standards, fire prevention, pollution and product liability

- **Risk control**

Risk control consists of four areas: risk avoidance, risk retention, risk transfer and risk reduction.

- ***Risk avoidance:*** **It refers to the conscious decision by the management to avoid completely a particular risk by discontinuing the operation producing the risk.**
- ***Risk retention:*** **It refers to retaining a particular risk for which any consequent loss is financed by the organization.**
- ***Risk transfer:*** **It refers to the legal assignment of the cost of certain potential losses from one party to another (example, by insurance).**
- ***Risk reduction:*** **It refers to the reduction or elimination of all aspect of accidental loss that lead to a wastage of an organization's assets.**

4.10. Safety lessons from " the Challenger"

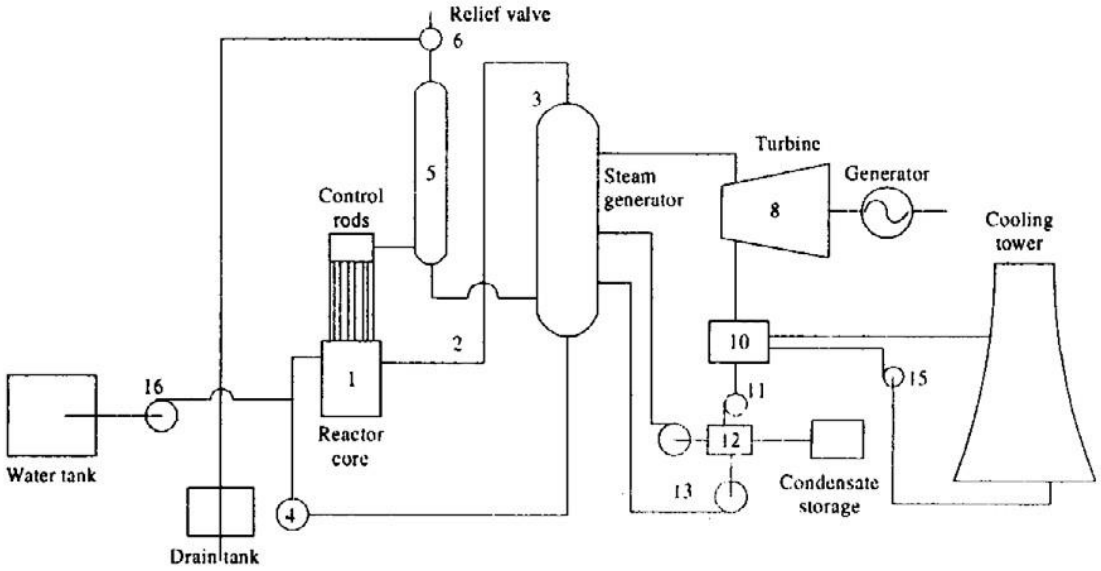
- Negligence in design efforts. The booster rocket casing recovered from earlier flights indicated the failure of filed-joint seals. No deign changes were incorporated. Instead of two O-rings, three rings should have been fixed. But there was no time for testing with three rings. At least three rings could have been tried while launching.
- Tests on O-rings should have been conducted down to the expected ambient temperature i.e., to 20^{o}F. No normalization of deviances should have been allowed.
- NASA was not willing to wait for the weather to improve. The weather was not favorable on the day of launch. A strong wind shear might have caused the rupture of the weakened O-rings.
- The final decision making of launch or no-launch should have been with the engineers and not on the managers. Engineers insisted on 'safety' but the managers went ahead with the 'schedule'.
- Informed consent: The mission was full of dangers. The astronauts should have been informed of the probable failure of the O-rings (field joints). No informed consent was obtained, when the engineers had expressed that the specific launch was unsafe.
- Conflict of interest (Risk vs. Cost): There were 700 criticality-1 items, which included the field joints. A failure in any one of them would have cause the tragedy. No back-up or stand- bye had been provided for these criticality-1 components.
- Escape mechanism or 'safe exit' should have been incorporated in the craft. McDonnell **Douglas, the** engineer, designed an abort module to allow the separation of the orbiter, when triggered by field joint leak. Unfortunately such a safe exit was rejected due to the increase in the cost, simultaneously with reduction in payload
- **Ethical engineers** should have given awards and encouraged to hold their discretion (moral autonomy) in risky situations, and to report to appropriate agency their views in the interest of public safety

4.11. Case study: Power Plants

4.11.1. Three – Mile Islands

The TMI nuclear Power Plant Unit 2 is located in a river basin in Pennsylvania, USA (March 28, 1979, 4 a.m.)

The nuclear power plant had a Pressurised Water Reactor system (PWR). The main reactor core (1) release heat which is transferred to water in the primary circuit (1-2-3-4). The heat from the steam generator (3) is transferred to water in the secondary circuit (7) at low pressure. The water in the secondary circuit gets converted into steam in the boiler (3). This steam flow drives the turbine (8), and the exhaust stem is converted into water in the condenser (10) and circulated back into the boiler (3) by means of pumps (11,13,14)



System components of TMI - 2 plant

The demineraliser (12) contains resin beads to clean condensate. A problem in the demineraliser arose and this led to the closure of the outlet valve of (12) to the steam generator (3). This resulted in shut down of main feed water pump (13) and the auxiliary feed water pump (14) failed.

The reactor pressure increased to very high level, opened a pressure relief valve (6) and gave a signal (SCRAM), which helped to lower the control rods in the reactor core, in order to stop the main fission process. This valve (6) remained opened for long.

When pump (14) failed, the steam generator (3) went dry. So, heat was not removed from the reactor. Water was pouring out at 220 gallons/min but reactor has not cooled down. Pumps (16) were started to refill water reactor core. There was too much of water in the reactor now. The reactor fuel rods began to break to pieces.

Then the chemical reaction between steam and the Zinc alloy fuel elements produced Hydrogen and the Hydrogen accumulated caused the explosion of the structure. The radiation levels in the building increased and the sound alarm blew. Immediately people contacted Nuclear Regulatory Commission and B and W, who constructed the reactor. Nobody was there to answer the call at B and W. But somehow people escaped without any loss of human lives. After 13 hours and a half, the reactor was put under control.

4.12. Chernobyl, near Klev, Russia (April 1986)

The RBMK (Acronym for water cooled and graphite moderated) reactors were graphite moderated and they use water tubes. A test on the turbine generator was planned to be conducted during a scheduled plant shut-down maintenance.
To conduct the test, the power plant output was reduced to 700 MW. But due to a sudden and unexpected demand, the power output has to be raised.

- To go ahead with the test, the reactor operators had already disconnected the emergency core-cooling system, ignoring the raise in demand situation.
- Further, a control device was not properly reprogrammed to maintain power at 700-100 MW level
- The test was conducted at 200 MW power out-put which is very low for the test. They should have shut down the reactor.
- The operators blocked all emergency signals and automatic shut-down controls, thus all safety systems were disconnected.
- The operators raised control rods to increase power output and tried to continue the test.
- This made the reactor unsafe. The temperature of RBMK reactor increased and the fission rate increased.
- The test should have been postponed but continued. The reactor core melted and due to the Hydrogen accumulation, the reactor caught fire and the radioactive waste began to spread out in USSR and also Europe.

The people living around were informed after a few hours and were evacuated 12 hours after the explosion. More than 30 workers in the complex lost their lives, while 200 workers sustained burns. About 8000 people lost their lives. The agricultural products were affected due to contaminated radioactive water, for several years.

4.13. Safety lessons from TMI and Chernobyl

1. The thickness of the containment should be more, to withstand the possible explosion and further damage due to radiation and leakage over the surroundings (Chernobyl).
2. When the test began at low loads, the demand for increased outpower should have been declined.

3. Or the tests should have been abandoned and all controls switched on. Then the output should have been increased (Chernobyl).
4. The decision making on test and increase the load should have been with one person or the decision makers should have coordinated with each other (Chernoby1).
5. Valves are the least-reliable components in the hydraulic system. Such a malfunction of the pressure relief valve and lack of information about its opening (or closing) were reported elsewhere in the past. But there was no 'learning from the past' (TMI).
6. Continuous monitoring of the components such as demineraliser and the pressure operated relief valve must have been made (TMI).
7. A comprehensive precursor program (emergency procedures) should have been implemented to record a few accident sequences and map these events to risk models. The mapping based on technical and human factors give us accounts, how people react and interact under conditions of stress (TMI).
8. Periodical mock drill of emergency for the operators (safe exit) should have been arranged (TMI and Chernoby1).
9. In-stack radioactivity monitoring instrument indicated a rise earlier. The operators at TMI 2 should have informed the superiors at once. People residing in the neighborhood ought to have been informed and steps initiated to evacuate the public immediately (TMI especially, and also Chernobyl).

4.14. Responsibilities of Engineers

4.14.1. Internal responsibilities of Engineers (responsibilities to Employers)

- In today's competitive world, the success of any organization relies on its **team play**
- Team play involves virtues of
  - **a. Collegiality**
  - **b. Loyalty**
  - **c. Respect for Authority**
  - **d. Collective Bargaining**

a. Collegiality

What is meant by collegiality?

- **Collegiality is th tendency to support and cooperate with the colleagues**
- According to National Society of Professional Engineers (NSPE) code, the collegiality should include the following three characteristics
  - **Engineers** should not attempt to injure, unkindly or falsely, directly or indirectly, the professional reputation, prospects, practice or employment of other Engineers
  - Engineers should not untruthfully criticize other Engineers
  - Engineers should bring unethical or illegal practice of other engineers to the proper authority for action
- **Collegiality is defined by Craig lhara as a kind of connectedness grounded in respect for professional expertise and in a commitment to the goals and values of the profession**

Elements of Collegiality

(i) Respect

Respect in collegiality indicates the following:

- Valuing one's colleagues for their professional expertise.
- Valuing one's colleagues for their dedication in offering service to the public through their profession.

For example, producing socially useful and safe products.

Collegial respect ought to be reciprocal *i.e.*, it must be of mutual type.

(ii) Commitment

It refers to sharing a devotion to the moral ideals inherent in the practice of engineering. Even though there is a fierce competition among the profession of engineers, they must share their ideas with one another for the betterment of the society.

(iii) Connectedness

It is an awareness of being part of a cooperative undertaking created by shared commitments and expertise. Having a sense of connectedness promotes two things namely cooperation and support.

Collegiality as a Virtue

Collegiality has to be considered as a valuable character (important virtue) which is to be encouraged among engineers and other professionals. This can be analysed from the viewpoints of the society and professionals.

From the society's view, collegiality is a means of value to promote the goals of professionals and to act with responsibility towards the colleagues with adequate level of motivation.

From the perspective of professionals, collegiality is more valuable. It is mainly responsible, for pursuing the good for the general public.

Negative aspects of collegiality

- Collegiality may be misused and distorted.
- Collegiality may degenerate more groups of self interest, rather than groups of shared devotion to the public good
- Because of tough competition among Engineers, collegiality can focus on the corporate goal of maximizing profit at the expense of the public good

b. Loyalty

- The quality of being loyal.
- A feeling or attitude of devoted attachment and affection.

Loyalty, as a general term, signifies a person's devotion or sentiment of attachment to a particular object, which may be another person or group of persons, an ideal, a duty, or a cause.

There are two senses of loyalty– (*i*) agency loyalty, (*ii*) identification loyalty.

1. Agency Loyalty

It is an obligation to fulfill his/her contractual duties to the employer. The duties are specific actions one is assigned, and in general cooperating with others in the organization. It consists of several obligations to employers. But, for the engineers, the paramount obligation is still "the safety, health, and welfare of the public"

Example: People may not like the job they do not hate their employer, but still they would perform their duty as long as they are employers. This sense of loyalty is known as Agency Loyalty

2. Identification Loyalty

- It is concerned with the attitudes, emotions, and a sense of personal identity. It includes willingness to meet moral duties, with attachment, conviction, and trust with employer. The attitude loyalty is more a virtue than an obligation. This type of loyalty is all right when the organizations work for productivity or development of community. Working together in falsification of records or serious harm to the public, does not merit loyalty. Further, with frequent takeovers or merger resulting in large-scale layoff, employees find it difficult to maintain attitude-loyalty
- Some of the specific duties of loyal employers are:
  - To avoid conflicts of interest
  - To inform employers of any possible conflicts of interest
  - To protect confidential information
  - To be honest in making estimates and
  - To admit one's errors

Obligations of loyalty

Within a proper limit, agency loyalty to employers is an obligation. An identification loyalty may be considered as obligatory when it fulfills the following conditions:

- Employees must be clear with the goals.
- Employees must be treated in a fair manner.

Misguided loyalty

Employees can harm companies and the general public by the name of loyalty. This loyalty is designated as misguided or inappropriate loyalty. Loyalty does not mean just obeying the orders of higher authorities. It has to bring facts and employees do not manipulate or hide facts thinking that it is an act of loyalty and it is good for the company.

Professionalism and Loyalty

The relationship between professional responsibility and loyalty to the companies can be explained as follows:

1. Work with an attitude of serving the public instead of willingly following the orders of the company.
2. Loyalty to organizations should not be the same as obeying the immediate supervisor/ boss.
3. Obligations to the public and to the employer (company) should go in the same direction that is, there should not be any contrast between the moral status of employers and professionals.

c. Respect for Authority

- **What is meant by Authority?**
  - Decisions can be taken by a few people, but putting into action requires larger participation from different groups of people, such as operation, purchase, sales, accounts, maintenance, finance etc.
  - In effectively-and efficiently-transferring decisions to actions, the authority comes into play a great role.
  - Otherwise the individual discretions may ruin the activities. Further the authority fixes the personal responsibility and accountability uniquely on each person. This is necessary to ensure progress in action.
  - **Authority can be defined as the legal right to command action by others and to enforce compliance**
  - **Authority provides a way to identify the areas of person's responsibility and accountability**
- **Sources of authority**
  - Person's position or rank
  - Personal attributes such as charisma. Knowledge and expertise

i. Institutional Authority

- Institutional authority can be defined as the institutional right given to a person to exercise power based on the resources of institution
- It is the authority exercised within the organization. It is the right given to the employees to exercise power, to complete the task and force them to achieve their goals.
- Duties such as resource allocation, policy dissemination, recommendation, supervision, issue orders (empower) or directions on subordinates are vested to institutional authority, e.g., Line Managers and Project Managers have the institutional duty to make sure that the products/projects are completed successfully.

- The characteristics features of institutional authority are that they allocate money and other resources and have liberty in execution.

ii. Expert Authority

On the other hand, the Expert Authority is (a) the possession of special knowledge, skills and competence to perform a job thoroughly (expertise), (b) the advice on jobs, and (c) is a staff function.

In order to avoid the problems in institutional authority (*i.e.*, incompetence). Expert authority is the possession of special knowledge, sill, or competence to perform some tasks or to give sound advice. For example, doctors are authorities on health matters, civil engineers are authorities on structures and aesthetics of building, lawyers are authorities in law matters and computer professionals are the authorities on software, hardware etc.

The name for expert authority is "authority for leadership" since it involves the expertise to effectively direct others.

In most of the cases, engineers will have expert authority in matters related to technology, while institutional authority will be held by line managers who look after the day-to-day activities of the organization.

Authority vs power

Authority	Power
It is the legal right of a superior which compel his subordinates to perform certain acts	It is the ability of the person to influence others to perform on an act, it may not have legal sanction
It is delegated to an individual by a superior	It is earned by an individual through his own effects
It lies in the position held and the authority changes with change in position	It rests in the individual. Even when the position has changed, his power remains with him
It is mostly well defined and finite	It is undefined and infinite

iii. Moral Justified Authority

An employer may have the institutional authority to direct engineers to perform something that is not morally justified. The engineers may have the institutional duty to obey the employer to do morally unjustified issues. So, institutional rights and duties cannot be applied in the same sense with rights and duties that are morally justified.

The institutional authority is morally justified, only when the goals of the institution are morally permissible or morally desirable and the manner in which it is exercised does not violate other moral duties.

iv. Accepting Authority

Employees mostly accept the guidance and obey their employer, seldom disobey on moral grounds. Each employee of an organization has something called as "Zone of acceptance" that shows their interest to accept their employee's authority. Most of the times, employees expand their zone of acceptance without looking into whether the authority demands moral acts or not. This reveals that the employees lack moral integrity. Hence, the employer's directives are to be evaluated carefully by the employees in order to have moral justifications before going a head to accept the directive.

v. Paramount obligations

- **The** code of ethics of the professional societies state that an engineer's paramount obligations is to protect the public health, safety, and welfare rather than obligations of loyalty and faithful service to employers
- As professional Engineers have obligation to accept their employer's institutional authority. But this does not mean that they have to obey obligations blindly. Therefore the basic moral task of engineers is to be aware of their obligations to obey employers on the one hand and to protect and serve the public and clients on the other hand
- Engineers must weigh their obligations to the public, their employers, their colleagues and others when conflicts between such obligations rise

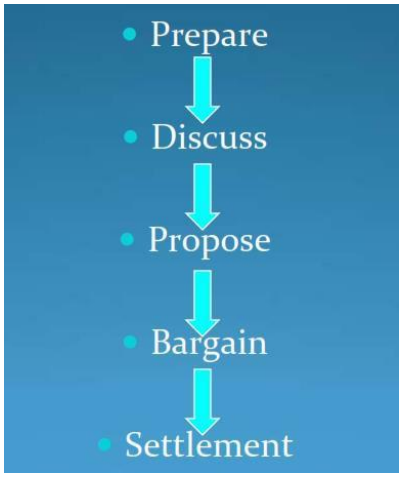
d. Collective Bargaining

What is meant by collective Bargaining?

- **International labor organization has defined collective bargaining as "negotiation about working conditions and terms of employment between an employer and one or more representative employee's with a view to reaching agreement".**
- **The process is collective in the sense that the issue relating to terms and conditions of employment are solved by representatives of employees and employers rather than individuals**
- **The term bargaining refers to evolving an agreement using methods like negotiation, discussion, exchange of facts and ideas rather than confrontation**

- **The Indian Scenario:**
  - Gandhiji - the leader of the Ahmedabad textile workers
  - Idea gathered interest only after the Second World War
  - GOI took steps like setting up of machinery for negotiations, conciliation and arbitration.

Process of collective bargaining



Types of Collective Bargaining

Conjunctive / Distributive Bargaining:

- Distributive bargaining is the most common type of bargaining & involves zero-sum negotiations, in other words, one side wins and the other loses.
- Both parties try to maximize their respective gains.
- They try to settle economic issues such as wages, benefits, bonus, etc.
- For Example, Unions negotiate for maximum wages & the management wants to yield as little as possible while getting things done through workers.
- In distributive bargaining, unions and management have initial offers or demands, target points (e.g.: desired wage level), resistance points (e.g.: unacceptable wage levels) & settlement ranges (e.g.: acceptable wage level). Another name for this type of bargaining is conjunctive bargaining.

Cooperative /Integrative Bargaining:

- Integrative bargaining is similar to problem solving sessions in which both sides are trying to reach a mutually beneficial alternative, i.e. **a win-win situation**.
- Both the employer & the union try to resolve the conflict to the benefit of both parties.
- Both sides share information about their interests and concerns and they create a list of possible solutions to best meet everyone's needs.
- For Example, when companies are hit by recession, they cannot offer the kind of wages and benefits demanded by workers. At the same time they cannot survive without the latter's support. Both parties realize the importance of surviving in such difficult times and are willing to negotiate the terms of employment in a flexible way.

Productivity Bargaining:

- The concept of productivity bargain involves a good understanding of the following concepts.
- Based on these concepts both the parties must develop a productivity linked scheme
- Difference between productivity & work intensity
- How to conduct work study
- ILO guidelines for work study – Personal needs allowance, Fatigue allowance, hazardous allowance , etc.
- Other Methods like MOST (Maynard Operational Sequence Techniques)

- Systems improvement and method improvement
- Required Skills and Knowledge for productivity settlement

Composite Bargaining:

- Workers believed that productivity bargaining agreements increased their workloads. Rationalization, introduction of new technology, tight productivity norms have added to this burden and made the life of a worker somewhat uneasy. As an answer to such problems, labor has come in favor of composite bargaining.
- In this method, labor bargains for wages as usual, but goes a step further demanding equity in matters relating to work norms, employment levels, manning standards, environmental hazards , sub-contracting clauses etc. This works in the favor of the workers, for e.g., when unions negotiate standards they ensure the workload of workers don't exceed

Concessionary Bargaining:

- Quite opposite to the other forms of bargaining, where the unions demanded from the employers, in concessionary bargaining, the objective is to giving back to management some of what it has gained in previous bargaining.
- Why should labor be willing to give back what it has worked so hard to obtain?
- A good example is the agreement between General Motors & the International Union of Electric Workers that granted GM around the clock operations, wages and benefits concessions for the new hires, and a two-week mass vacation. The concessions were made to save over 3,000 jobs.
- In some cases, despite a financial crisis, the union may not be willing to concede. This may be because the union doesn't view management's arguments as credible. Thus, the degree of trust and credibility between the management and the union may influence the extent to which concessionary bargaining occurs.

Faithful Agent or Trustee?

- Professional societies such as NSPE and IEI refuse to accept the 'collective coercive action' of unionism, holding the principles of professional integrity as right, e.g., as per NSPE code III, i.e., engineers shall not promote their own interest at the expense of the dignity and integrity of the profession. The

engineers are said to exhibit a higher standard than self-interest; and they are expected to perform an ethical duty to their employer as faithful agent or trustee. The actions of unions are usually against the interests of the employers and they use coercion and force against the employers. These actions are interpreted as unprofessional and disloyal. But in certain cases, the safety of the workers had been ignored for a long period or the employees were under-paid for years. Can we still hold the action as unethical?

It can be concluded from this discussion, that

(*a*) The duty of the employee to one's employer does not mean sacrifice of monetary self-interests, and

(*b*) trustee or faithful agent means executing the assigned tasks and safeguarding the property. It does not nullify the right to negotiate for safe and hygienic working conditions, and economic benefits collectively.

(*c*) The codes insist that the paramount obligation is to the society, as compared to their employers. The duty to the employers is also limited by considerations such as workers safety, and the right to disobey illegal or unethical activities. After all the employees are also parts of the society, and

(*d*) Can collective and coercive action be resorted, when all other efforts have failed?

Service go the public

The service to the public is of foremost importance. But the unions promote the interests of a few members only. The public welfare should not suffer because of their actions. Imagine a situation when all the teachers, medical practitioners, and ambulance drivers go on strike. Will this not cause damage to the public safety and health?

Collective bargaining by engineers through union or association or forums may act within limits set by the concern for the public welfare. Professional societies can play a great role in the promotion and establishment of principles and practices towards fair employment and exploitation. But they can not function as collective bargaining agents.

The collective bargaining can not be judged as unethical, unless we study the cases individually and decide. The collective bargaining is acceptable per se, but the means should be constructive, persuasive, firm based on mutual understanding, and not destructive, disruptive, and not harming the persons or property.

Professionalism and Unionism

- Collective bargaining assumes Unionism, legally any organization employing more than 20 employees could have union, and as well as more than one union is permitted
- The employee form unions to safeguard the interests of employee ad prevent exploitation of employees
- Many professional engineers argued that the ethical aspects of professionalism in engineering are inconsistent with union ideology and practice
- According to John Kemper, the unionism and professionalism are conflicting with each other. Professionalism offers paramount importance to the interests of society and employer. But union also known as collective bargaining agents, consider the economic interest o the members ahead of the interest of the employer
- Professional societies have emphasized loyalty to employer and the public is not possible with any form of collective bargaining

- The professional societies instruct the engineers indirectly not to become members of Union because of the issue of conflicting loyalties and on the grounds that it is unprofessionalism
- It is impossible for an engineer to belong to a union and at the same time to maintain the standards of his profession

Assessment on Unionism

The moral assessment on Unions is a complex process. A careful consideration of all relevant moral facts are to be inquired into and judged. It can not be generalized, because of the divergent views on unionism, as shown in Table. 4.1.

Table. 4.1 Pro- and anti-views on unionism

For unionism	*Against unionism*
1. Unions have been useful in improving the standard of living and economic benefits of the workers. Even non-union members leading to inflationary condition are able to get those benefits.	1. Unions have lead to disturb the economy of state by salaries, and increase salaries and expenses, leading to inflationary conditions.
2. Unions have obtained greater participation in organization, by participative management. Union members are appointed as Directors in the Board and credited to act as bridge between the employers and employees.	2. Instead of being cooperative, they act in negative and destructive ways, causing loss of man-days. Opinions of the individual worker is suppressed and used as pawns.
3. Unions have contributed to the job security, and protection against arbitrary treatment to the employees.	3. Unions encourage mediocrity, and act in favor of seniority-based promotion. Merit-based promotion and awards for personal achievement are disregarded
4. They are able to put resistance to unethical orders and support to ethical actions	4. Unions thrive on prolonged unrest, dissatisfied, and tense relations between workers and management.
5. They have provided for effective grievance redressal mechanism for employees.	5. They cause pigeon-holing of employee in narrow job classifications to which the salary scales are attached.
6. They act to safeguard against the possible political interference, exploitation, and alienation in the company affairs.	

4.14.2. External responsibilities of Engineers (responsibilities to the outside world)

External responsibilities refer to the responsibilities of the engineers to the outside world. They include

a) **Confidentiality**
b) **Conflicts of Interest**
c) **Occupational crimes**

a) Confidentiality

What is confidentiality?

- The legally required process of keeping secret.
- Confidentiality is the guarantee that data is not shared with unauthorized entities.
- The quality of protection against unauthorised accessed to private or secret information.
- Restrictions on the accessibility and dissemination of information.
- Ensuring that information is accessible only to those authorized to have access.

Keeping confidence is one of the most central and widely acknowledged duties of any professional. Doctors should keep information of patients confidential, salaried engineers should keep information of their company confidential and even teachers must keep at least personal information of their students confidential.

What is meant by confidentiality Information?

- Confidentiality Information is information deemed desirable to keep secret
- According to code of ethics of ABET " Engineers shall treat confidential information coming to them in the course of their assignments as confidential
- Confidential information is any information that the employer/client would like to keep secret in order to complete effectively against business rivals

Terms related to Confidential Information

On the basis of *acquisition (possession)*, the confidential information are divided into two types, as follows:

1. Priveleged Information

It is information that is available and accessed, by virtue of a privilege, i.e., privilege of being employed on that assignment. The security check is also insisted during exit from the work place against the leakage of this type of information. An engineer working on defense project may know that the missile he has developed is to be tested against the terrorists across the border.

2. Proprietary Infromation

It is the information *owned* by the organization. It refers to the knowledge and procedures established by and in the organization. Some internal communication in an organization is marked as 'proprietary'. It is protected legally by the organization from use by others, including the employees. The trade secret is proprietary information that has not been made public. A limited legal protection is available for this proprietary information by common law, which prevents employees from disclosing it to outsiders. The *quality manual* is another example for proprietary information.

On the basis of *severity* of risk from breach, the confidential information is divided as:

1. *Obvious information*: It refers to data, information, and test results on the products yet to be released, or designs, formulae, and technical processes of the products. The risk or loss from the breach is large and may threaten the survival.
2. *Information of lesser confidentiality*: This relates the business information such as the number of employees working on projects, the identity of vendors or suppliers, customers, marketing strategies, yield of manufacture, cost of manufacture, substitution of materials etc. The risk or loss involved is relatively less. In competitive business situations, this information also plays a vital role.

3. Trade Secrets

- A trade secret can be type of information that has not become public and which an employer has taken steps to keep secret
- These trade secrets may be about designs, technical processes, plant facilities, quality control systems, business plans, marketing strategies and so on
- Trade secrets are given limited legal protection against employer or contractor abuse. An employer can sue employees or contractors for leaking trade secrets or even planning to do so.

4. Patents

- **Patents** legally protect specific products from being manufactured and sold by competitors without the permission of the patent holder

	Patent	Trade Secret
What does it protect?	Covers new, useful inventions	Covers valuable, secret information
How does it protect my IP?	Gives you the right to exclude others from making, selling, using, importing	Protects only against "misappropriation"
What must you disclose?	Invention becomes public	Information remains secret
How do you get it?	Formal application, examination by patent office	No application or registration required
How long before it takes effect?	2-3 years, on average	As long as it takes to establish and maintain internal procedures
How long is it valid?	20-year term	Potentially perpetual
How much does it cost?	Between $30,000 to $50,000 per patent, per country	No application fees; only administrative costs for establishing internal procedures and staffing

What types of information should be kept confidential?

- Information about the unreleased product
- Test results and data about the product
- Design or formula of a product
- Data about a technical processes
- Organization of plant facilities
- Quality control procedures
- Business information such as number of employees working on the project, the suppliers list, marketing strategies, production cost and production yield

Justification for Confidentiality

- Confidentiality can be justified by various ethical theories. According to Rights-based theory, rights of the stakeholders, right to the intellectual property of the company are protected by this practice. Based on Duty theory, employees and employers have duty to keep up mutual trust. The Utilitarian theory holds good, only when confidentiality

produce most good to most people. Act utilitarian theory focuses on each situation, when the employer decides on some matters as confidential.

- **The following moral principles also justify the concept of 'confidentiality':**

1. Respect for Autonomy

It means respecting the freedom and self-determination of individuals and organizations to identify their legitimate control over the personal information of themselves. In the absence of this, they can not keep their privacy and protect their self-interest.

2. Respect for Promises

This means giving respect for the promises made between the employers and employees. Employees should not disclose the promises given to the employers. This information may be considered as sensitive by the employer. But promises do not establish complete obligations.

3. Trustworthiness

Maintaining confidentiality by lawyers, accountants, and attorneys are necessary to develop confidence and welfare of the individuals and the organizations. It does not mean however that these professionals collude with them unethically.

4. Respect for Public Welfare

This moral consideration is important in identifying relationships in professional transactions, for the benefit of public welfare, e.g., if the medical practitioners keep confidentiality on the problems of patients, patients develop confidence and trust in them, they feel free to reveal their problems and personal information, without being shy. This is likely to increase their chances of being cured. Similarly, a company keeping confidentiality about its products gets economic benefits of competitiveness. Besides, the public are also benefited from a healthy competition. An attorney keeping the data on clients confidential, provide safety and welfare of the clients as well as the public.

Changing jobs and confidentiality

Is Switching Job Ethical?

- When persons change jobs (employers), what happens to their moral obligation? The obligation to protect the information does not cease, when one shifts to another employee. Otherwise, the former employee will reveal this information to the new employer or sell it to a competitor of the former employer. The integrity of the employee, even upon switching the employer demands that he maintains confidentiality and does not to divulge the information. The professional integrity of engineers is more valuable than the loyalty to the current employer.
- Many engineers value professional advancement than long-term tie and loyalty to a single employer.
- The engineers involved in research and development and expert contribution change jobs. Normally they are familiar with the innovative developments in the parent organizations. For example, one manufacturing expert along with his colleagues as well as with some secret documents left General Motors and joined Volkswagen. This violation of trade secret, lead the V W to pay huge compensation to GM in cash and compulsion to buy parts from GM for seven subsequent years.
- Employees, who change jobs, will not able to withhold their knowledge and expertise. They are sought after only for their expertise. They may not carry the papers and but their active brain always carry memories. Although some organizations hold that this is unethical, the individuals cannot be prevented from divulging the facts to benefit the

current employer. The courts have held a moral verdict. Even though the previous employers had the right to maintain their trade secrets confidential, the personal rights of the employees, who switched job in pursuit of career advancement, had to be honored and balanced.

Management Policies for maintaining confidentiality

How can we protect the rights of the employers and at the same time recognize the genuine personal rights and other rights of the engineers/employees?

Some of the management practices and their limitations are discussed hereunder:

1. One way is to restrict the future employment of employees, by using employment contracts at the time of their exit. Details such as the restriction on geographical location, time gap between the departure from one place and engagement with the other employer, and on the type of jobs that one can perform with future employer, are entered in to contracts. But such contracts have not been given legal sanction.
2. An incentive instead of threatening their rights by the employment contract, may offer some positive benefits in exchange for the restrictions listed. A lump sum post-employment payment or compensation over a specific period may offered as incentive to restrict him.
3. Another approach by the management is to effect tighter controls on internal information flow on trade secrets and other vital features. But this is likely to create a mutual distrust in the organization and to throttle the creativity of engineers involved in the research and development. A better understanding between the ethical management and the professional responsibility of the engineers will fulfill both professional concerns and employee loyalty.

b) Conflicts of Interest

A conflict of interest occurs when the employee has more than one interest. A professional conflict of interest is the situation where the professional has an interest that, if pursued, might prevent him from meeting his obligations to his employers or clients, e.g., an Electrical Engineer working in the State Electricity Board may have a financial interest in a company which supplies electrical instruments. If the engineer is decide on the bid for the supply of electrical instruments, a clear case of conflict of interest exists.

A 'conflict of interest' is different from 'conflicting interests'. A student has to clear four arrears subjects in the supplementary examination. But he finds that the time available is sufficient to study only three subjects. This is a situation of 'conflicting interests', where he has two or more desires that can not be fulfilled under the given circumstances. But there is no moral problem involved in pursuing all subjects. In case of professional conflict of interest, there is a possibility of pursuing all the conflicting interests, thereby inviting a moral problem.

Types of conflicts of Interest

Several types of conflicts of interests exist depending on the ways and severity of outside interests. A few common types are discussed here.

1. Actual Conflict of Interest

This refers to the situation where the objectivity is lost in decision making, and the inability to discharge the duty to the employer. It is the result of weaker judgment and service. A Civil Engineer working in the Public Works Department has a financial interest in a contracting company, which has submitted a bid for the construction of a bridge. There may be a variety of outside interests. But the conflict arises when the outside interest influences or threatens the professional judgment in serving the employer or clients.

2. Apparent Conflict of Interest

This is explained in the following example. An engineer is paid based on a per cent of the cost of the design and there is no incentive for him to cut the costs. In this situation, it appears that the engineer makes the design more expensive in order to get larger commission for him. This situation leads to doubting the engineer's interest and ability for professional judgment.

3. Potential Conflict of Interest

There are situations where the interest of an employee extends beyond the current employer and into the interest on one's spouse, relative or friend. The interest changes into intimacy and subsequent non-moral judgments against the interest of the employer and in favor of the outsider or even a potential competitor.

(a) Favorable Contact

When an engineer's spouse is working for a contractor or vendor, a conflict does not arise. But if the engineer is to give a subcontract to the contractor or purchase order to the supplier, the conflict arises. This happens even when the engineer has partial or substantial stockholding in the business of that contractor or supplier.

(b) ***Gifts, Bribes, and Kickbacks.***

- **A bribe is a substantial amount of money or goods offered beyond a stated business contract with the aim of winning an advantage in gaining or keeping the contract, and where the advantage is illegal or otherwise unethical.**
- It is something offered to influence or convince. *Substantial* is a vague term, but it alludes to amounts, beyond acceptable gratuities, that are sufficient to distort the judgment of a typical person. Typically, although not always, bribes are made in secret.
- **Bribes are illegal and immoral because of the following reasons**
  - Bribes corrupt free market economic system and is anti competitive
  - It corrupts justice and public policy by allowing rich people to make all the rules. Hence in today's business only large and powerful companies survive, since they are capable of providing bribes
  - Bribery treats people as commodities that can be bought or sold. This practice degrades the human beings and corrupts both the buyer and seller
- **Prearranged payments made by contractors to companies or their representatives in exchange for contracts actually granted are called kickbacks.**

- When suggested by the granting party to the party bidding on the contract, the latter often defends its participation in such an arrangement as having been subjected to "extortion."

- **Gifts are not bribes as long as they are small gratuities offered in the normal conduct of business.**

Table 4.2 How does bribe differ from gift?

Tests	*Bribe*	*Gift*
1. Timing	Given before	Given after
2. Cost of item	Large amount	Small amount, articles of daily use
3. Quality of product	Poor	Good/High
4. Giver is a friend	Yes	No
5. Transparency	Made in secret	Made in open
6. Motive	Expect undue favor	Expect a favor or thanking for the favor
7. Consequence on organization's goodwill	Damaging the goodwill and reputation	No damage is involved

- Codes of ethics do not encourage even gifts, but employees have set forth flexible policies. Government and company policies generally ban gifts more than a nominal value (>Rs.1000?)
- **An additional thumb rule is that the acceptance of gift should not influence one's judgment on merit.**

(c) Moonlighting

- It is a situation when a person is working as employee for two different companies in the spare time. This is against the right to pursue one's legitimate self-interest. It will lead to conflict of interests, if the person works for competitors, suppliers or customers, while working under an employer. Another effect of moonlighting is that it leaves the person exhausted and harms the job performance in both places.

(d) Insider Information

- Another potential conflict of interest is when using 'inside' information to establish a business venture or get an advantage for oneself or one's family or friends.
- The information may be either of the parent company or its clients or its business partners, e.g., engineers might inform the decision on the company's merger with another company or acquisition or an innovative strategy adopted.
- In such cases, their friends get information on stock holding and decide on trading their stocks to sell or buy quickly, so that gain more or prevent a loss.
- For example, in WorldCom USA, the insider information was used to manipulate and sell a large amount of stock holding by the Director, upon knowing that the government has declined to admit their product.

Ways to avoid conflicts

- **A good way to avoid conflicts of interest is**
  - To follow the guidance of the company policy.
  - In the absence of such a policy, asking a coworker or your manager will give you a second opinion and will make it clear that you aren't trying to hide something.
  - In the absence of either of these options, it is best to examine your motives and use ethical problem-solving techniques.
  - Finally, you can look to the statements in the professional ethics codes that uniformly forbid conflicts of interest. Some of the codes have very explicit statements that can help determine whether or not your situation is a conflict of interest.

c) Occupational Crimes

An occupational crime may be committed by (1) wrong actions of a person through one's lawful employment or (2) crime by an employee to promote ones own or employer's interest or (3) theft or pilferage by the employee or (4) damage to the property or an employee of one's organisation. These are also called *white-collared crimes.*

Many of these crimes are examples of conflicts of interest. These are motivated by the greed, corporate ambition, and misguided loyalty. Even the crime to promote the interests of the employer, is an occupational crime. Some of the examples of occupational crimes are:

1. *Price Fixing*

Fixing the bidding rate by companies, in collusion with other companies, especially for the contract/services, is called *price fixing*. This is an occupational crime, prevalent in electrical equipments industries, where there used to be a few contractors but large number of contracts. Because of this, public as well as the government incur huge loss. Two top officers of Westinghouse and GE, USA who were involved in price fixing without the knowledge of their Directors, were sentenced to imprisonment a few years back. These officers held that it was legal to fix price and even argued that this procedure is really beneficial to the people! However, the court did not accept this view.

2. *Industrial Espionage*

It means simply spying for personal or company benefits, e.g., in the Silicon Valley area, there are several company manufacturing computer chips, ICs, and microprocessors. There are a lot of engineers who are entrepreneurs and venture capitalists. The espionage is more prevalent here because of the following factors:

(*a*) The development of chips is extremely competitive and on fast track. Profit and loss can be made quicker.

(*b*) Manufacture of chips is very costly. Huge saving through reverse engineering could be made only by breaking open the competitors' gadgets or fast tests. Some organizations prefer to steal the design details through illegal means rather testing and development.

(*c*) The components involved are very small. Hence, pilferage or removal of gadgets could be done easily and without being caught.

(*d*) The crime detection and law enforcement are difficult and ineffective.

(*e*) Employees do not carry out the activities directly, but through engineers who were employees or through the weakest link in the supplier-producer chain.

3. *Bootlegging*

Manufacturing, selling or transporting products (liquor and narcotics) that are prohibited by law, is called *bootlegging*. In engineering context, it refers to working on projects which are prohibited or not properly authorized.

4. *Endangering Lives (Occupational Hazards)*

Industries who expose their employees to hazards usually escape penalties. Victims have the right to sue, but only to claim some monetary compensation. The *asbestos* industries in USA were responsible for the death of one lakh workers and 27 million workers afflicted with cancer, in the 80s. Even after 22 years since Bhopal gas tragedy, appropriate compensation has not been paid. Even the government could not bring to book the culprits for the crime committed.

Occupational Health and Safety Assessment Series, OHAS-18001 Certification has been adopted in many Indian Industries. As per the Annual report of RIL[10], an initiative called Project CASH, Change Agent for Safety and Health, had been formed to bring about a positive change and continual improvement in occupational health practices at the work place, besides attitudinal and behavior changes. This is claimed to have prevented work-related diseases, injuries, reduced absenteeism, and ultimately increased the productivity level.

4.15. Professional Rights

- Engineers have several types of moral rights like human, employee, contractual, and professional rights.
    - As *humans,* engineers have fundamental rights to live and freely pursue their legitimate interests, which implies, for example, rights not to be unfairly discriminated against in employment on the basis of sex, race, or age.
    - As *employees,* engineers have special rights, including the right to receive one's salary in return for performing one's duties and the right to engage in the nonwork political activities of one's choosing without reprisal or coercion from employers.
    - As *professionals,* engineers have special rights that arise from their professional role and the obligations it involves. We begin with professional rights.

Three professional rights have special importance: (1) the basic right of professional conscience, (2) the right of conscientious refusal, and (3) the right of professional recognition.

a) Right of Professional Conscience.

- The right of professional conscience is the moral right to exercise professional judgment in pursuing professional responsibilities. Pursuing those responsibilities involves exercising both technical judgment and reasoned moral convictions.
- It is the right to do what everyone agrees it is obligatory for the professional engineer to do. But engineering, like other professions, calls for morally complex decisions. It

requires autonomous moral judgment in trying to uncover the most morally reasonable courses of action, and the correct courses of action are not always obvious.

- As with most moral rights, the basic professional right is an entitlement giving one the moral authority to act without interference from others. It is a "liberty right" that places an obligation on others not to interfere with its proper exercise.
- Special resources may be required by engineers seeking to exercise the right of professional conscience in the course of meeting their professional obligations. For example, conducting an adequate safety inspection may require that special equipment be made available by employers.
- **There are two general ways to justify the basic right of professional conscience**.
    - One is to proceed gradually by repeating the justifications given for the specific professional *duties*. The justification of each duty ultimately yields a justification of the right of conscience with respect to that duty.
        -
    - The second way is to justify the right of professional conscience directly, which involves grounding it more directly in the ethical theories. Thus, duty ethics regards professional rights as implied by general duties to respect persons, and rule-utilitarianism would accent the public good of allowing engineers to pursue their professional duties. Rights ethics would justify the right of professional conscience by reference to the rights of the public not to be harmed and the right to be warned of dangers from the "social experiments" of technological innovation.

b) ***Right of Conscientious Refusal.***

- **The right of conscientious refusal is the right to refuse to engage in unethical behavior and to refuse to do so solely because one views it as unethical.**
- This is a kind of second-order right. It arises because other rights to honor moral obligations within the authority-based relationships of employment sometimes come into conflict.
- According to this rights, no employer can force or pressure an employee to do something that the employees considers unethical and unacceptable
- There are two situations to be considered: (1) where there is widely shared agreement in the profession as to whether an act is unethical and (2) where there is room for disagreement among reasonable people over whether an act is unethical.
- It seems clear enough that engineers and other professionals have a moral right to refuse to participate in activities that are illegal and clearly unethical (for example, forging documents, altering test results, lying, giving or taking bribes, or padding payrolls).
- And forcing employees into acting by means of threats (to their jobs) plainly constitutes a violation of this right of theirs.

c) ***Right of Recognition.***

- **Engineers have a right of professional recognition for their work and accomplishments**. Part of this involves fair monetary remuneration, and part nonmonetary forms of recognition.

- The right to recognition, and especially fair remuneration, may seem to be purely a matter of self-interest rather than morality, but it is both. Without a fair remuneration, engineers cannot concentrate their energies on carrying out the immediate duties of their jobs and on maintaining up-to-date skills through formal and informal continuing education.
- The right to reasonable remuneration is clear enough to serve as a moral basis for arguments against corporations that make excessive profits while engineers are paid below the pay scales of blue-collar workers. It can also serve as the basis for criticizing the unfairness of patent arrangements that fail to give more than nominal rewards to the creative engineers who make the discoveries leading to the patents.
- The recognition /reward may be given in two types:
  - Intrinsic awards: These are related to non monetary remunerations. Such as acknowledging achievements by issuing appreciation letters, certificates and oral phrases
  - Extrinsic Awards: this is related to monetary remunerations such as increased salaries, commissions, cash bonus, gain sharing etc.

4.16. Employee Rights

- **Employee rights are any rights, moral or legal, that involve the status of being an employee.**
- They overlap with some professional rights, they also include institutional rights created by organizational policies or employment agreements, such as the right to be paid the salary specified in one's contract.
- **Ewing refers to employee rights as the "black hole in American rights."** The Bill of Rights in the Constitution was written to apply to government, not to business. But we haven't foreseen the giant corporations that have emerged in our century. Corporations wield enormous power politically and socially, often in multinational settings; they operate much as mini governments, and they are often comparable in size to those governments the authors of the Constitution had in mind. For example, American Telephone & Telegraph in the 1970s employed twice the number of people that inhabited the largest of the original 13 colonies when the Constitution was written.

The provisions made to the employees under this category are:

1. Professional rights (discussed already)
2. Basic human rights (discussed already)
3. Institutional rights or contractual employee rights. This include the rights to the institution due to the organisational policies or contracts, right to receive specified salary and annual increments, and profit sharing. The quantum of such benefits, scale of pay etc. are fixed and reviewed periodically by the employers and employees.
4. Non-contractual employee rights: These are the rights provided in common, besides the contractual ones. They include:

1. ***Privacy Right.*** The right to pursue outside activities can be thought of as a right to personal privacy in the sense that it means the right to have a private life off the job. The right to privacy means the right to control the access to and the use of information about oneself. As with the right to outside activities, this right is limited in certain instances by employers' rights. For example, the personnel division needs medical and life insurance information about employees, but immediate supervisors usually do not.

Consider a few examples of situations in which the functions of employers conflict with the right employees have to privacy:

- Job applicants at the sales division of an electronics firm are required to take personality tests that include personal questions about alcohol use and sexual conduct.
- A supervisor unlocks and searches the desk of an engineer who is away on vacation without the permission of that engineer. The supervisor suspects the engineer of having leaked information about company plans to a competitor and is searching for evidence to prove those suspicions.
- A large manufacturer of expensive pocket computers has suf-fered substantial losses from employee theft. It is believed that more than one employee is involved. Without notifying employees, hidden surveillance cameras are installed.
- A rubber products firm has successfully resisted various attempts by a union to organize its workers. It is always one step ahead of the union's strategies, in part because it monitors the phone calls of employees who are union sympathizers. It also pays selected employees bonuses in exchange for their attending union meet-ings and reporting on information gathered. It considered, but rejected as imprudent, the possibility of bugging the rest areas where employees were likely to discuss proposals made by union organizers.

2. ***Right to Equal Opportunity: Preventing Sexual Harassment.***
   - One definition of sexual harassment is: **"the unwanted imposition of sexual requirements in the context of a relationship of unequal power.".** It takes two main forms: quid pro quo and hostile work environment.
   - ***Quid pro quo*** **includes cases where supervisors require sexual favors as a condition for some employment benefit (a job, promotion, or raise).** It can take the form of a sexual threat (of harm) or sexual offer (of a benefit in return for a benefit).
   - ***Hostile work environment,*** **by contrast, is any sexually oriented aspect of the workplace that threatens employees' rights to equal opportunity**. It includes unwanted sexual proposals, lewd remarks, sexual leering, posting nude photos, and inappropriate physical contact.
   - Sexual harassment is a particularly invidious form of sex discrimination, involving as it does not only the abuse of gender roles and authority relationships, but the abuse of sexual intimacy itself.
   - Sexual harassment is a display of power and aggression through sexual means. sexual harassment constitutes an infringement of one's autonomy to make free decisions concerning one's body. But whether or not coercion and manipulation are used, it is an assault on the victim's dignity. In abusing sexuality, such harassment degrades people on the basis of a biological and social trait central to their sense of personhood.
   - Thus a duty ethicist would condemn it as violating the duty to treat people with respect, to treat them as having dignity and not merely as means to personal enhancement and gratification of one's sexual and power interests. A rights ethicist would see it as a serious violation of the human right to pursue one's work free from the pressures, fears, penalties, and insults that typically accompany sexual

harassment. And a utilitarian would emphasize the impact it has on the victim's happiness and self- fulfillment, and on women in general. This also applies to men who experience sexual harassment.

3. ***Right to Equal Opportunity: Nondiscrimination.***
    - Discrimination because of one's sex, race, skin color, age, or political or religious outlook. These aspects of biological makeup and basic conviction lie at the heart of self-identity and self-respect. This discrimination which means a morally unjustified treatment of people on arbitrary or irrelevant grounds—is especially destructive within the work environment, f
    - **Consider the following two examples:**
    - An opening arises for a chemical plant manager. Normally such positions are filled by promotions from within the plant. The best qualified person in terms of training and years of experience is an African American engineer. Management believes, however, that the majority of workers in the plant would be disgruntled by the appointment of a nonwhite manager. They fear lessened employee cooperation and efficiency. They decide to promote and transfer a white engineer from another plant to fill the position.
    - A farm equipment manufacturer has been hit hard by lowered sales caused by a flagging produce economy. Layoffs are inevi-table. During several clandestine management meetings, it is decided to use the occasion to "weed out" some of the engineers within 10 years of retirement to avoid payments of unvested pen-sion funds.
    - These examples involve (immoral) discrimination. They also involve the violation of the Civil Rights Act of 1964 and the 1967 Age Discrimination in Employment Act, respectively.
4. ***Right to Equal Opportunity: Affirmative Action.***
    - **Affirmative action, as the expression is usually defined, is giving a preference or advantage to a member of a group that in the past was denied equal treatment, in particular, women and minorities.**
    - The *weak form* of preferential treatment consists in hiring a woman or a member of a minority over an equally qualified white male.
    - The *strong form*, by contrast, consists in giving preference to women or minorities over better-qualified white males.
    - **Examples**
        - white male engineer, was denied entrance to the medical school at the University of California, Davis (UC Davis), which reserved 16 of 100 openings for applicants who were either black, Latino, Asian, or American Indian. He sued, arguing that his credentials were superior to many of the minority students accepted. The Supreme Court ruled that the UC Davis admissions program was unconstitutional because it used explicit numerical quotas for minorities, which prevented person-to-person comparisons among all applicants. Yet the court also ruled that using race as one of many factors in comparing applicants is permissible, as long as quotas are avoided, and the

intent is to ensure the goal of diversity among students—an important educational goal.

Table 4.3 Pro- and against-preferential treatments

In favor of preferential treatment	*Against reverse preferential treatment*
1. Compensatory justice: Violations of rights in the past must be compensated. Usually this treatment is extended to all in the group rather than individuals. 2. Racial and sexual violation and violence still exist today. To counterbalance this, the reverse preferential treatment is necessary to ensure equal opportunity to minorities and women. 3. It has produced desirable consequences It has raised the social and economic status and provided them role models and have promoted self-esteem.	1. It violate the rights to equal opportunity for majority, to compete on merits. 2. Compensation may be given only to specific individuals and not for all. 3. Provide special funding and education for the disadvantaged. But jobs should not be used as a compensatory tool. 4. Reduces the productivity, as the merit is the casualty. Self-doubts and indecision affect others' morale and efficiency.

5. **Right to choose outside activities**

This is also interpreted as a right to personal privacy as that means a right to have a private life outside the job. There are some situations when this right can be curbed. For example,

1. When those activities lead to violation or found detrimental to the duties of their job.
2. When the activities of the employees form a conflict or interest (e.g., when moonlighting).
3. When the interest of the employer is getting damaged (if the employee transfers some vital information on plans or strategies to the competitor).

6. Right to due process from employer

It is the right to fair process or procedures in firing, demotion and in taking any disciplinary actions against the employees. Written explanation should be initially obtained from the charged employee and the orders are given in writing, with clearly-stated reasons. Simple appeal procedures should be framed and made available to all those affected. Fairness here is specified in terms of the process rather than the outcomes.

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4.17. Whistle – Blowing

- **Whistle-blowing is the act by an employee of informing the public or higher management of unethical or illegal behavior by an employer or supervisor.**
- There are frequent newspaper reports of cases in which an employee of a company has gone to the media with allegations of wrongdoing by his or her employer or in which a government employee has disclosed waste or fraud.

- According to the codes of ethics of the professional engineering societies, engineers have a duty to protect the health and safety of the public, so in many cases, an engineer is compelled to blow the whistle on acts or projects that harm these values.
- Engineers also have the professional right to disclose wrongdoing within their organizations and expect to see appropriate action taken.

4.17.1. Definition

- **Whistle blowing is alerting relevant persons to some moral or legal corruption, where relevant persons are those in a position to act in response, if only by registering protested**
- **Whistle blowing occurs when an employee or former employee coveys information about a significant moral problem outside approved organization channels to someone in a position to take action on the problem**

4.17.2. Aspects

There are four aspects of whistle blowing, namely:

1. ***Basis of disclosure***: The basis for disclosure may be intentional, or under pressure from superiors or others not to disclose.

2. ***Relevance of topic***: The whistle blower believes that the information is about a significant problem for the organization or its business ally. It can be a threat to the public or employees' health, safety and welfare or a criminal activity, or unethical policies or practices, or an injustice to the workers within the organization.

3. ***Agent*****:** The person disclosing the information may be a current or former employee or a person having a close link to the organization.

4. ***Recipient***: The person or organization, who receives the information, is in a position to remedy the problem or alert the affected parties. Usually, the recipients are not aware of the information fully or even partially.

4.17.3. Types of Whistle Blowing

- **Based on the *destination (recipient)*, whistle blowing is classified into types, as:**

(a) *Internal*: In this case, the information is conveyed to a person within the organization, but beyond the approved channels.

(b) *External*: This happens when the information is transmitted outside the organization. The recipient may be a municipal chairman or member of legislature or minister. It becomes severe if the information reaches the press and through them the public. The damage is maximum and sometimes poses difficulty in remedying the situation.

- **Based on the origin or source (agent), this can be divided into three types, as follows:**

(a) *Open*: The originator reveals his identity as he conveys the information. This information is reliable and true, but sometimes partially true.

(b) *Anonymous*: The identity is concealed. The information may or may not be true. But the agent anticipates perhaps some repression or threat, if identity is revealed.

(c) *Partly anonymous (or partly open)*: Such a situation exists when the individual reveals his identity to the journalist, but insists that the name be withheld from others.

4.17.4. When should be whistle blowing be attempted

Whistle-blowing should only be attempted if the following four conditions are met [Harris, Pritchard, and Rabins, 2000]:

1. *Need*. There must be a clear and important harm that can be avoided by blowing the whistle. In deciding whether to go public, the employee needs to have a sense of proportion. You don't need to blow the whistle about everything, just the important things. For example, if an accident occurs at your company, resulting in a spill of a small quantity of a toxic compound into a nearby waterway that is immediately cleaned up, this incident probably doesnot merit notifying outside authorities. However, if this type of event happens repeatedly and no action is taken to rectify the problem despite repeated attempts by employees to get the problem fi xed, then perhaps this situation is serious enough to warrant the extreme measure of whistle-blowing.
2. *Proximity*. The whistle-blower must be in a very clear position to report on the problem. Hear say is not adequate. Firsthand knowledge is essential to making an effective case about wrongdoing. This point also implies that the whistleblower must have enough expertise in the area to make a realistic assessment of the situation. This condition stems from the clauses in several codes of ethics which mandate that an engineer not undertake work in areas outside her expertise. This principle applies equally well to making assessments about whether wrongdoing is taking place.
3. *Capability*. The whistle-blower must have a reasonable chance of success in stopping the harmful activity. You are not obligated to risk your career and the financial security of your family if you can't see the case through to completion or you don't feel that you have access to the proper channels to ensure that the situation is resolved.
4. *Last resort*. Whistle-blowing should be attempted only if there is no one else more capable or more proximate to blow the whistle and if you feel that all other lines of action within the context of the organization have been explored and shut off.

4.17.5. Preventing whistle Blowing

- There are four ways in which to solve the whistle-blowing problem within a corporation.
- **First, there must be a strong corporate ethics culture**. This should include a clear commitment to ethical behavior, starting at the highest levels of management, and mandatory ethics training for all employees. All managers must set the tone for the ethical behavior of their employees.
- **Second, there should be clear lines of communication within the corporation.** This openness gives an employee who feels that there is something that must be fi xed a clear path to air his concerns.
- **Third, all employees must have meaningful access to high-level managers** in order to bring their concerns forward. This access must come with a guarantee that there will be no retaliation. Rather, employees willing to come forward should be rewarded for their commitment to fostering the ethical behavior of the company.
- **Finally, there should be willingness on the part of management to admit mistakes**, publicly if necessary. This attitude will set the stage for ethical behavior by all employees.

4.17.6. When to Justify

Under the following situations, the whistle blowing may be justified:

1. When the potential harm existing is identified as serious, or anticipated to occur with a high probability, in the near future.
2. When sufficient data on the harm had been gathered and adequately documented. This condition may not be required if revealing the information would jeopardize the national interests or help the competitors. A request to the appropriate authority for external investigation or permission by a court to release the information may be a solution.
3. The concerns have been reported earlier to the immediate superiors and no satisfactory response was forthcoming from them, within a reasonable time.
4. Regular channels within the organization have been used to transport the information to the highest level of management and the information has reached them. Situations 3 and 4 may not be appropriate, when one's supervisors are the main source of the problem or when urgency demands that regular channels are expected to only add the delay.
5. There is a reasonable hope that the whistle blowing can prevent or remedy the damage existing or anticipated.

Professional societies, unions, and some central laws are there to protect the genuine whistle blowers, but the route is full of adventure still. Laws alone are not sufficient. The engineers and other employees have to act as watch dogs and provide necessary legal assistance to the blowers. The IEEE has taken active roles by assisting the members, backing them when they are to face legal proceedings, helping the engineers discharged unjustly, and honoring the courageous whistle blowers with public recognitions.

To conclude, the whistle blower has to consider (*a*) the personal obligation to family (*b*) right to pursue one's career and (*c*) sometime sacrifices, before this venture.

4.17.7. Before you blow a whistle

Here are some of the instructions that should be followed before blowing the whistle:

1. One should familiarize with the rules for appealing within the organization. Normal organizational channels, up to the ombudsman or top ethics committee, should be tried, except when extreme urgency conditions exist.
2. Consult the trusted colleagues for advice and to avoid isolation.
3. Use polite and tactful language. Avoid any personal criticisms that may antagonize and divert the attention towards solving the problems.
4. Keep the supervisors informed of your actions, through informal discussion and formal memorandum.
5. Keep your observations and claims precise and accurate. Prepare formal records of events in support of your claims.
6. Before going outside the organization, consult the ethics committee of your professional society.
7. If necessary consult a lawyer regarding potential litigations.
8. Offering to resign is one of the peaceful and effective methods of blowing your views. Whether you are relieved from the specific project or from the organization, either way your autonomy and self-respect are recognized.

4.18. Intellectual Property Rights

4.18.1. What is intellectual property Rights?

- Intellectual Property (IP) is a property that results from mental labor
- The IP is originating mainly from the activities of the human intellect
- IP is the information and original expression that derives its original value from creative ideas, and is with commercial value.
- IPR permits people to have independent ownerships for their innovations and creativity, like that of own physical property. This encourages the IP owners towards innovation and benefit to the society. It is an asset that can be bought or sold, licensed, and exchanged. It is intangible i.e., it cannot be identified by specific parameters.

4.18.2. What are IPR?

- The agreements with World Trade Organization (WTO) and Trade-Related aspects of Intellectual Property System (TRIPS) have been adopted effective from January 2005. Besides the minimum standards set for protection of IP rights, appropriate laws framed by the member countries are expected to reduce distortions and barriers for and promote the international trade.
- The global IPR system strengthens protection, increases the incentives for innovation, and raises returns on international technology transfer. However, it could raise the costs of acquiring new technology and products, shifting the global terms of trade in favor of technology producers.

4.18.3. Need for Protection of IP

- IP plays an essential role to stabilize and develop the economy of a nation. This protection actually stimulates creativity, research, and innovation by ensuring freedom to individuals and organizations to benefit from their creative intellectual investments. The IP serves many purposes, namely

(a) it prevents others using it,
(b) prevent using it for financial gain,
(c) prevent plagiarism
(d) fulfill obligation to funding agency. ICICI Bank has advanced loan against IP as security to Shopper's Stoppe, New Delhi, and
(e) provides a strategy to generate steady income.

- **Some of the challenges in the acquisition of IP are:**

(a) Shortage of manpower in the industry. Educational institutions can play a vital role in providing the same.
(b) High cost of patenting and lengthy procedure. This was being considered by the Government and a simpler and faster procedure is expected, and
(c) Lack of strong enforcement mechanism.

4.18.4. Types and Norms

The agreements establish norms and conditions for the following instruments of intellectual properties:

a) Patents

- Patent is a contract between the individual (inventor) and the society (all others). Patents protect legally the specific products from being manufactured or sold by others, without permission of the patent holder. Patent holder has the legally-protected monopoly power as one's own property.
- The validity is 20 years from the date filing the application for the patent. It is a territorial right and needs registration.
- The Patent (Amendment) Act 2002 guarantees such provisions.
- Patent is given to a product or a process, provided it is entirely new, involving an inventive method and suitable for industrial application. While applying for a patent, it is essential to submit the documents in detail regarding the problem addressed, its solution, extent of novelty or innovation, typical applications, particulars of the inventor, and the resources utilized. Inventions are patentable and the discoveries are not.

2. Copyright

- The copyright is a specific and exclusive right, describing rights given to creators for their literary and artistic works. This protects literary material, aesthetic material, music, film, sound recording, broadcasting, software, multimedia, paintings, sculptures, and drawings including maps, diagrams, engravings or photographs. There is no need for registration and no need to seek lawyer's help for settlement. The life of the copyright protection is the life of the inventor or author plus 50 years.
- **Copyright gives protection to particular expression and not for the idea. Copyright is effective in**

(a)) preventing others from copying or reproducing or storing the work,
(b)) publishing and selling the copies,
(c)) performing the work in public, commercially
(d)) to make film
(e)) to make translation of the work, and

(f)) to make any adaptation of the work. Copying the idea is called 'plagiarism' and it is dealt with separately.

- **Can software be protected through copyright?** Indian copyright Act amended in 1984 included the rights of in a computer program as literary work. Many countries protect software as a copyright. Some holds the view that copyright is not the right type of protection for software. They held that the patents and trade secrets are more appropriate forms of protecting software. While trade secret is the most conventional form of protection of software, in the recent years, both patents and copyrights are adopted to protect software.
- Copyright (Amendment) Act 1999, India ensures fair dealing of broadcasting through the internet. The concerns of Book industry, Music Industry, Film and Television Industry, Computer Industry and Database Industry are sufficiently met by this updated Act.

3. Trademarks

- **Trademark is a wide identity of specific good and services, permitting differences to be made among different trades.** It is a territorial right, which needs registration. Registration is valid initially for 10 years, and renewable. The trademark or service mark may be registered in the form of a device, a heading, a label, a ticket, a letter, a word or words, a numeral or any combination of these, logos, designs, sounds, and symbols.
- Trademark should not be mistaken for a design, e.g., the shape of a bottle in which a product is marketed, can not be registered as a trademark. Trademarks Act 1999 made in compliance with TRIPS agreement, provides further details.
- **There are three functions of trademark:**
  a. Just as we are identified by our names, good are identified by their trademarks. For example, the customer goes to the shop and asks for Lux soap. The word 'Lux' is a trade mark. In other words it shows the origin or source of the goods.
  b. The trademark carries with it an inherent indication or impression on the quality of goods, which indirectly demonstrates that it receives the customer's satisfaction.
  c. The trademark serves as silent sales promoter. Without a trademark, there can be no advertisement. In other words, it serves as a medium for advertising the goods.
- The marks should be distinctive i.e., it should be able to distinguish from one good to the other. The terms used for trademarks are usually generic, descriptive, and suggestive. Some of the term which are not distinctly distinguishing the goods or services from others, are called *generic term* and are eligible for protection under trademarks. The descriptive term should clearly indicate or convey the specific purpose, function, physical characteristic and the end use of the product.

4. Trade secret

A trade secret is the information which is kept confidential as a secret. This information is not accessed by the any other (competitor) than the owner and this gives a commercial advantage over the competitors. The trade secrets are not registered but only kept confidential. These are given limited legal protection, against abuse by the employee or contractor, by keeping confidentiality and trust.

The trade secrets may be formulae, or methods, or programs, or processes or test results or data collected, analyzed, and synthesized. These are related to designs, technical processes, plant facilities, list of suppliers or customers etc. This information should not be disclosed or used by any other person.

5. **Design of Integrated circuits**
   - It is the right granted to the inventor to prevent anybody making use of the design of IC , semiconductor devices and other electronic devices
6. **Geographical indications**
   - **Geographical** identification identifies goods as originating in the territory of a country, an origin or a locally in that territory, where specific quality, reputations or other characteristics of the goods is essentially attributed to other Geographical conditions
   - Examples: Tirunelveli halwa, dindugal locks, Sivakasi crackers etc.

4.18.5. Benefits of IPR's

- Promote technological, industrial and economical developments of a country
- Provide incentives for the inventions and ensure adequate returns on commercialization of the invention
- Prevent the competitors from using one's invention
- Useful in identifying unprotected areas to avoid violation
- Grants exclusive rights to the inventors
- Use the invention for the public purpose
- Useful in identifying unexplored areas for undertaking research so as to become a leader in that area

Part A

1. Define safety

- **Safety means state of being safe, safe means protected from danger harm.**
- **The term safety is always difficult to describe completely, what may be safe for one person may be risk for another one.**
- **The *American Heritage Dictionary* safety as freedom from damage, injury, or risk.**
- The definition for safety is defined by William.W. Lowrence as follows:
  - **A thing is safe if its risks are judged to be acceptable.**

2. What does the term collective bargaining means

   i. **International labor organization has defined collective bargaining as "<u>negotiation about working conditions and terms of employment between an employer and one or more representative employee's with a view to reaching agreement".</u>**
   ii. **The process is collective in the sense that the issue relating to terms and conditions of employment are solved by representatives of employees and employers rather than individuals**

iii. **The term bargaining refers to evolving an agreement using methods like negotiation, discussion, exchange of facts and ideas rather than confrontation**

3. Define risk benefit analysis

- **Risk benefit analysis is similar to cost benefit analysis used to analyze the risk in a project and to determine whether the project should be carried out or not**
- **The major reasons for the analysis of the risk benefit are:**
  .1. To know risks and benefits and weigh them each
  .2. To decide on designs, advisability of product/project
  .3. To suggest and modify the design so that the risks are eliminated or reduced

4. What is meant by whistle blowing
   - **Whistle blowing is alerting relevant persons to some moral or legal corruption, where relevant persons are those in a position to act in response, if only by registering protested**
   - **Whistle blowing occurs when an employee or former employee coveys information about a significant moral problem outside approved organization channels to someone in a position to take action on the problem**

5. What is IPR

- Intellectual Property (IP) is a property that results from mental labor
- The IP is originating mainly from the activities of the human intellect
- IP is the information and original expression that derives its original value from creative ideas, and is with commercial value.
- IPR permits people to have independent ownerships for their innovations and creativity, like that of own physical property. This encourages the IP owners towards innovation and benefit to the society. It is an asset that can be bought or sold, licensed, and exchanged. It is intangible i.e., it cannot be identified by specific parameters.

6. What is risk analysis

Risk analysis is the process of defining and analyzing the dangers to individuals, businesses and government agencies posed by potential natural and human-caused adverse events.

UNIT V GLOBAL ISSUES

UNIT V GLOBAL ISSUES

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

5.1. Multinational Corporations

- Organizations, who have established business in more than one country, are called Multinational Corporation. The headquarters are in the home country and the business is extended in many host countries. The Western organizations doing business in the less-economically developed (developing, and overpopulated) countries gain the advantage of inexpensive labor, availability of natural resources, conducive-tax atmosphere, and virgin market for the products.
- At the same time, the developing countries are also benefited by fresh job opportunities, jobs with higher remuneration and challenges, transfer of technology, and several social benefits by the wealth developed. But this happens invariably with some social and cultural disturbance. Loss of jobs for the home country, and loss or exploitation of natural resources, political instability for the host countries are some of the threats of globalization.

5.1.1. International Human Rights

- To know what are the moral responsibilities and obligations of the multinational corporations operating in the host countries, let us discuss with the framework of rights ethics. Common minimal rights are to be followed to smoothen the transactions when the engineers and employers of MNCs have to interact at official, social, economic and sometimes political levels.
- At international level, the organizations are expected to adopt the minimum levels of (a) values, such as mutual support, loyalty, and reciprocity, (b) the negative duty of refraining from harmful actions such as violence and fraud, and (c) basic fairness and practical justice in case of conflicts.
- **The ten international rights to be taken care of, in this context are:**
    1. Right of freedom of physical movement of people
    2. Right of ownership of properties
    3. Freedom from torture
    4. Right to fair trial on the products1
    5. Freedom from discrimination on the basis of race or sex. If such discrimination against women or minorities is prevalent in the host country, the MNC will be compelled to accept. MNCs may opt to quit that country if the human rights violations are severe.
    6. Physical security. Use of safety gadgets have to be supplied to the workers even if the laws of the host country do not suggest such measures.
    7. Freedom of speech and forming association
    8. Right to have a minimum education
    9. Right to political participation
    10. Right to live and exist (i.e., coexistence). The individual liberty and sanctity of the human life are to be respected by all societies.

5.1.2. Technology Transfer

- It is a process of moving technology to a new setting and implementing it there. Technology includes hardware (machines and installations) and the techniques

(technical, organizational, and managerial skills and procedures). It may mean moving the technology applications from laboratory to the field/factory or from one country to another. This transfer is effected by governments, organizations, universities, and MNCs.

5.1.3. Appropriate Technology

- Identification, transfer, and implementation of most suitable technology for a set of new situations, is called appropriate technology. Technology includes both hardware (machines and installations) and software (technical, organizational and managerial skills and procedures).
- Factors such as economic, social, and engineering constraints are the causes for the modification of technology. Depending on the availability of resources, physical conditions (such as temperature, humidity, salinity, geographical location, isolated land area, and availability of water), capital opportunity costs, and the human value system (social acceptability) which includes their traditions, beliefs, and religion, the appropriateness is to be determined.
- For example, small farmers in our country prefer to own and use the power tillers, rather than the high-powered tractors or sophisticated harvesting machines. On the other hand, the latest technological device, the cell phones and wireless local loop phones have found their way into remote villages and hamlets, than the landline telephone connections. Large aqua-culture farms should not make the existing fishermen jobless in their own village.
- The term appropriate is value based and it should ensure fulfillment of the human needs and protection of the environment.

5.1.4. How Appropriate is Aptech?

- A case against the technology transfer is that the impact of borrowed or transferred technology has been threatening the environment beyond its capacity and sustainable development of the host countries. Large plantations that orient their efforts to exports leave the small farmers out of jobs and at the mercy of the foreign country. For example, genetically modified cotton have shown sufficient disturbance in Europe and Africa. This has made the European Union to oppose the entry of G.M. cotton into Europe.
- The high technology has contributed to large-scale migration from villages to the cities where corporations are located, leading to the undesirable side-effects of overcrowding of cities, such as the scarcity of water, insanitation, poverty, and the increase in crimes.
- The term ‘appropriate’ should emphasize the social acceptability and environmental protection of the host countries, and this need to be addressed while transferring technology. Thus, we confirm the view that engineering is a continual social experimentation with nature.

5.1.5. MNCs and Morality

- The economic and environmental conditions of the home and host countries may vary. But the multinational institutions have to adopt appropriate measures not to disturb or dislocate the social and living conditions and cultures of the home countries. A few principles are enlisted here:
  1. MNC should respect the basic human rights of the people of the host countries.
  2. The activities of the MNC should give economic and transfer technical benefits, and implement welfare measures of the workers of the host countries.
  3. The business practices of the multinational organisations should improve and promote morally justified institutions in the host countries.

4. The multinationals must respect the laws and political set up, besides cultures and promote the cultures of the host countries.
5. The multinational organisations should provide a fair remuneration to the employees of the host countries. If the remuneration is high as that of home country, this may create tensions and if it is too low it will lead to exploitation.
6. Multinational institutions should provide necessary safety for the workers when they are engaged in hazardous activities and 'informed consent' should be obtained from them.cAdequate compensation should be paid to them for the additional risks undertaken.

Advantages of Multinational Corporations

1. Multinational corporations provide an inflow of capital.

Multinationals are a leading source of capital inflows to the developing world, building factories, investing in training centers, and supporting educational facilities with the intention of improving their productive capacities overseas.

2. Multinational corporations reduce government aid dependencies in the developing world.

The current level of trade for Europe is at 60%. North America experiences a 40% level of trade, while the Southeast Asian Nations achieve 30%. The current level of trade for African countries, however, is just 12%. Multinational corporations could boost this rate in the developing world by up to 50%.

3. Multinational corporations allow countries to purchase imports.

When multinationals build a presence in the developing world, their capital inflows help countries have more access to the import/export market. That allows them to access better goods, create more opportunities, and eventually raise the standard of living for everyone.

4. Multinational corporations provide local employment.

If you step outside of the developed world for a moment, the average person works in an agriculture-related position. Almost 70% of the jobs found in the poorest countries of the world are based on this industry, compared to less than 5% which is located in the wealthiest nations in the world. Multinationals come in, offer higher wages (which are still low compared to global standards), then shift the standard of living.

5. Multinational corporations improve the local infrastructure.

Companies must have employees who can access job sites to become productive. That means an investment in the local infrastructure becomes necessary before operations even begin. Roads, bridges, and technology access are three of the largest barriers taken down when multinationals become active in a developing country. .

6. Multinational corporations diversify local economies.

Multinationals provide these economies with more variety, creating diversity in local production levels. That reduces reliance on commodities which often have volatile prices because their supply and demand levels waiver so often.

7. Multinational companies create consistent consumer experiences.

Multinationals work from a centralized structure, which means there is a basic expectation that every asset will look and perform as every other one does. Even though a McDonald's in India serves different products than one in the United States, the core values of the company are still on display.

8. Multinational corporations encourage more innovation.

The average multinational corporation spends between 5% to 10% of its annual budget on innovative research. Many of the companies with the most intensive research and development intensity are the multinationals who are on the Fortune Global 500. Only two

companies, Apple and Stanley Black and Decker, qualify as high-leverage innovators because of their investments today. The world's largest spenders increased their investments by 11.4% in 2018 to total $782 billion.

9. Multinational corporations enforce minimum quality standards.

Most multinationals rely on vendors for their distribution work. Some even use them for sales opportunities. Because of their size and influence, these companies put leverage on their partners (including their suppliers) to provide an expected experience to each customer. If there is a failure to do so, the corporation can move to a different vendor immediately, which instantly kills some distribution businesses overseas. This structure creates efficiencies of scale that lower customer prices while still ensuring reasonably good product quality.

10. Multinational corporations increase cultural awareness.

When companies expand overseas, they become exposed to new cultural realities. Multinationals are incredibly diverse, which gives them added strength because of this necessity. One must know the pain points of the local market before you can produce goods or services for them. When anyone expands their thinking to include new perspectives, the world becomes a stronger place because of it. These companies offer a positive influence on cross-culture communication if this advantage becomes a top priority for them.

Disadvantages of Multinational Corporations

1. Multinational corporations create higher environmental costs.

One primary advantage which multinationals see in doing business in the developing world is a lack of robust environmental legislation. Weaker governments tend to exchange environmental harm for additional profits. When these companies can outsource their production to countries with these lower standards, it does lower prices, but it also creates more damage. Countries like India even trade in waste and rubbish because of the revenues they earn from recycling and disposal, creating the potential for harm to local soil and water supplies.

2. Multinational corporations don't always leave profits local.

There is evidence to show that the investments made by multinational companies improve the local infrastructure. Additional education and job training offer new opportunities for domestic workers. Once the investments are made, however, the profits earned by the company tend to be repatriated for use in other areas. If you were to look at the net inflow of capital instead of the gross, you usually find that the actual benefit offered by multinationals is quite low (and sometimes even negative).

3. Multinational corporations import skilled labor.

Multinationals invest in local workers to develop their skills, but they also need to get their venture off the ground quickly. Most companies in this position will import the skilled labor they require from other economies to meet their needs. That means the best jobs, especially in the developing world, are given to people who don't even live in the local economy. Those wages do not offer the same economic benefits because spending occurs internationally instead of at the local level.

4. Multinational corporations create one-way raw material resource consumption..

Many multinationals go into a new country looking to extract raw materials without infrastructure considerations, taking oil, rubber, or precious metals to create products. Those extraction efforts may cause several environmental concerns over time, from the pollution of rivers to the loss of landscape. The investments pay for the materials, but they don't always pay for the damage left behind.

5. Multinational corporations encourage political corruption.

When multinationals enter the region, promising to pay for access to raw materials and other needs, those in charge politically often prevent the investments from filtering down to the general population. Money usually gets siphoned off by politicians and officials, which creates massive disruption at the local level with only minor compensation (if any) from the government working with the corporation.

6. Multinational corporations support "sweatshop" labor.

Sweatshop labor is typically seen as a disadvantage to local economies. Although some experts suggest that any job and income is better than nothing at all, weak labor conditions allow multinationals to lower wages to the greatest extent possible to pad their own profit margins. Even when minimum salaries are legislated by the government, what workers earn in the developing world is very small.

7. Multinational corporations remove jobs from their home country.

Several jobs are more economical for multinationals to outsource or offshore the positions than hire domestically. Manufacturing jobs are outsourced most often, with multinationals focusing on Southeast Asia because of the lower labor costs involved. Call centers are outsourced frequently too, again because wages are lower overseas than in their home market. Writers and graphic designers are often outsourced because contract employees are cheaper than full-time staff. These companies might help other economies grow, but they can also create employment difficulties at home.

8. Multinational corporations build legal monopolies.

Even though the assets controlled by multinational corporations are managed by a centralized structure, governments treat each location as its own entity. That gives the companies more leeway in how they handle their consumer markets.

9. Multinational corporations put other companies out of business.

Walmart offers a relentless push for profits. One doesn't earn $500+ billion in revenues each year without it. That means the retailer puts constant pressure on suppliers to offer the lowest prices possible. On essential products which don't change, the price Walmart pays must drop year after year. That places a squeeze on the suppliers because the sheer size of the retailer allows it to receive concessions that kill local profits. Instead of "Buying American," as the brand used to trumpet, the company is now responsible for 10% of all Chinese exports to the United States.

5.1.6. Case Study: Bhopal Gas Tragedy

- The Union Carbide had 51% and the Indian subsidiary UC India Ltd. had 49% of stock. In 1983, there were 14 plants in India manufacturing chemicals, pesticides, and other hazardous products. The Bhopal plant had a license to make Methyl isocyanate-based pesticides. In November 1984, they had decided to close down the plant. For quite some years before the production rate was going down.
- In the history of chemical plants disasters, three other wake-up calls were reported. Flixborough accident in 1974 in U.K. when certain modifications carried out in the plant led to the leakage and explosion of cyclohexane, which killed 28 people.
- The Piper Alpha offshore oil platform disaster in 1988, near Scotland, killed 167 people and resulted in $ 2 billion losses. The third occurred in Toulouse, France in 2001, killing 29 people, and injuring thousands.
- A warehouse holding 300 tonnes of ammonium nitrate fertilizer exploded and damaged 10000 buildings, including schools, a university, and a hospital. But we have not learnt from the past.

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- **The cumulative effects of the following factors caused the tragedy in Bhopal on December 3, 1984.**

1. Maintenance was neglected and the trained maintenance personnel were reduced as economy measure. Need for quick diagnosis aggravates the situation by causing considerable psychological stress on the plant personnel.
2. Training activities for the supervisory personnel were stopped. This led to inadequate training of the personnel to handle emergencies.
3. Periodical Safety Inspection teams from U.S. which visited previously were also stopped. From the initial U.S. Standards, the safety procedures were reduced to low level Indian standards. The procedures had been deteriorating at these sites for weeks or months, prior to the accident. There was clear lack of management systems and procedures to ensure safety.
4. Vital spares for equipments and machineries were not available
5. Absence of capital replacement led to the stagnant economy of the plant.
6. The high turnover of the experienced engineers and technicians, who were demoralized by the lack of development.
7. Lack of experienced personnel to operate and control the vital installations.
8. They have not conducted a thorough process hazards analysis that would have exposed the serious hazards which resulted in disaster later.
9. No emergency plan was put in practice, during the shutdown and maintenance.
10. Above all, the commitment of top-level management to safety was lacking. They have been paying only lip service to safety of people of the host country.

Technologically, the tragedy was caused by a series of events listed:

1. The safety manual of Union Carbide prescribed that the MIC tanks were to be filled only up to 60% of the capacity. But the tanks were reported to have been filled up to 75%.
2. The safety policy prescribed that an empty tank should be available as a stand-bye in case of emergency. But the emergency tank was also filled with to its full capacity. These facts confirmed that the MNC had not followed and implemented appropriate safety standards of the home country in the host country
3. The storage tanks should be refrigerated to make the chemical less reactive. But here the refrigeration system was shut down as an economy measure. This raised the temperature of the gas stored.
4. The plant was shut down for maintenance two months earlier. The worker who cleaned the pipes and filters connected to the tanks and closed the valves, was not trained properly. He did not insert the safety disks to prevent any possible leakage of the gas. This led to the build up of temperature and pressure in the storage tanks.
5. When the gas started leaking out, the operators tried to use the vent gas-scrubber that was designed to reduce the exhausting gas. But that scrubber was also shut down.
6. There was a flare tower that was designed to burn-off the gas escaping from the scrubber. That was not also in working condition.
7. The workers finally tried to spray water up to 100 feet to quench the gas (which is water soluble). But the gas was escaping from the chimney of 120-feet high.
8. The workers were not trained on safety drills or emergency drills or any evacuation plans.

The gas escaped into the air and spread over 40 sq. km. About 600 people died and left 7000 injured and the health of about 2 million people was affected adversely. Even after 22 years, influence of the Central Government and the courts, the compensation had not reached all the affected people.

5.2.Environmental Ethics

5.2.1. What is environmental ethics?

- **Environmental ethics means conscious efforts to protect an environment and to maintain its stability from the hazardous pollutants**
- **Environmental ethics is the study to explore the ethical roots of the environmental movement and to understand what ethics tells us about our responsibility to the environment**
- Environmental ethics is the study of
  (a) Moral issues concerning the environment, and
  (b) Moral perspectives, beliefs, or attitudes concerning those issues.
- Engineers in the past are known for their negligence of environment, in their activities. It has become important now that engineers design eco-friendly tools, machines, sustainable products, processes, and projects.
- These are essential now to
  (a) Ensure protection (safety) of environment
  (b) Prevent the degradation of environment, and
  (c) Slow down the exploitation of the natural resources, so that the future generation can survive.
- The American Society of Civil Engineers (ASCE) code of ethics, has specifically requires that "engineers shall hold paramount the safety, health, and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of professional duties"
- The term sustainable development emphasizes on the investment, orientation of technology, development and functioning of organizations to meet the present needs of people and at the same time ensuring the future generations to meet their needs.
- Compaq Computer Corporation (now merged with HP) was the leader, who exhibited their commitment to environmental health, through implementation of the concept of 'Design for environment' on their products, unified standards all over the world units, and giving priority to vendors with a record of environmental concern.
- **Engineers as experimenters have certain duties towards environmental ethics, namely:**
  1. **Environmental impact assessment**: One major but sure and unintended effect of technology is wastage and the resulting pollution of land, water, air and even space. Study how the industry and technology affects the environment.
  2. **Establish standards**: Study and to fix the tolerable and actual pollution levels.
  3. **Counter measures**: Study what the protective or eliminating measures are available for immediate implementation
  4. **Environmental awareness**: Study on how to educate the people on environmental practices, issues, and possible remedies.

5.2.2. Disasters

✓ **Plastic Waste Disposal**

- In our country, several crores of plastic bottles are used as containers for water and oil, and plastic bags are used to pack different materials ranging from vegetables to gold ornaments. Hardly any of these are recycled.
- They end up in gutters, roadsides, and agricultural fields. In all these destinations, they created havoc. The worse still is the burning of plastic materials in streets and camphor along with plastic cover in temples, since they release toxic fumes and threaten seriously the air quality.
- Cities and local administration have to act on this, collect and arrange for recycling through industries.

✓ **E-waste Disposal**

- The parts of computers and electronic devices which have served its useful life present a major environmental issue for all the developing countries including India. This scrap contains highly toxic elements such as lead, cadmium, and mercury.
- Even the radioactive waste will lose 89% of its toxicity after 200 years, by which time it will be no more toxic than some natural minerals in the ground. It will lose 99% of its remaining toxicity over the next 30,000 years.
- The toxic chemical agents such as mercury, arsenic, and cadmium retain toxicity undiminished forever. But these scraps are illegally imported by unscrupulous agencies to salvage some commercially valuable inputs. Instead of spending and managing on the scrap, unethical organizations sell them to countries such as India. This is strictly in violation of the Basel Convention of the United Nations Environment Program, which has banned the movement of hazardous waste.
- A recent report of the British Environment Agency, has revealed that the discarded computers, television sets, refrigerators, mobile phones, and electrical equipments have been dispatched to India and Pakistan in large quantity, for ultimate disposal in environmentally-unacceptable ways and at great risk to the health of the labour.
- Even in the West, the electronic junk has been posing problems. Strong regulation including
  (a) pressure on industries to set up disassembling facilities,
  (b) ban on disposal in landfill sites,
  (c) legislation for recycling requirements for these junk and
  (d) Policy incentives for eco-friendly design are essential for our country.
- The European Union through the Waste Electrical and Electronic Equipment (WEEE) directive has curbed the e-waste dumping by member countries and require manufacturers to implement methods to recover and recycle the components.
- Indian Government expressed its concern through a technical guide on environmental management for IT Industry in December, 2004. It is yet to ratify the ban on movement of hazardous waste according to the Basel Convention.
- A foreign news agency exposed a few years back, the existence of a successful e-waste disposal hub in a suburb of New Delhi, operating in appallingly dangerous conditions. Our country needs regulations to define waste, measures to stop illegal imports, and institutional structures to handle safe disposal of domestic industrial scrap.

✓ **Industrial waste Disposal**

- **<u>There has been a lot of complaints through the media, on</u>**
  (a) Against the Sterlite Copper Smelting Plant in Thuthukkudi (1997) against its pollution, and

(b) When Indian companies imported the discarded French Warship Clemenceau for disposal, the poisonous asbestos compounds were expected to pollute the atmosphere besides exposing the labor to a great risk, during the disposal.

- The government did not act immediately. Fortunately for Indians, the French Government intervened and withdrew the ship, and the serious threat was averted!

✓ **Depletion of Ozone Layer**

- The ozone layer protects the entire planet from the ill-effects of ultraviolet radiation and is vital for all living organisms in this world. But it is eaten away by the Chloro-fluro-carbons (CFC) such as Freon originating from the refrigerators, air conditioners, and aerosol can spray. This has caused also skin cancer to sun-bathers in the Western countries.
- Further NO and NO gases were also found to react with the ozone. Apart from engineers, the organizations, laws of the country and local administration and market mechanisms are required to take up concerted efforts to protect the environment.

✓ **Global warming**

- Over the past 30 years, the Earth has warmed by 0.6 °C. Over the last 100 years, it has warmed by 0.8 °C. It is likely to push up temperature by 3^{o}C by 2100, according to NASA's studies.
- The U.S. administration has accepted the reality of global climate change, which has been associated with stronger hurricanes, severe droughts, intense heat waves and the melting of polar ice.
- Greenhouse gases, notably carbon dioxide emitted by motor vehicles and coal-fired power plants, trap heat like the glass walls of a greenhouse, cause the Earth to warm up.
- Delegates from the six countries — Australia, China, India, Japan, South Korea and US met in California in April 2006 for the first working session of the Asia Pacific Partnership on Clean Development and Climate. These six countries account for about half of the world's emissions of climate-heating greenhouse gases.
- Only one of the six, Japan, is committed to reducing greenhouse gas emissions by at least 5.2 per cent below 1990 levels by 2012 under the Kyoto Agreement.
- About 190 nations met in Germany in the middle of May 2006 and tried to bridge vast policy gaps between the United States and its main allies over how to combat climate change amid growing evidence that the world is warming that could wreak havoc by stoking more droughts, heat waves, floods, more powerful storms and raise global sea levels by almost a meter by 2100.

✓ **Acid Rain**

- Large emissions of sulphur oxides and nitrous oxides are being released in to the air from the thermal power stations using the fossil fuels, and several processing industries. These gases form compounds with water in the air and precipitates as rain or snow on to the earth. The acid rain in some parts of the world has caused sufficient damage to the fertility of the land and to the human beings.

5.2.3. Human centered environmental ethics

- This approach assumes that only human beings have inherent moral worth duly to be taken care of. Other living being and ecosystems are only instrumental in nature. Utilitarianism aims to maximize good consequences for human beings. Most of the goods are engineered products made out of natural resources.
- Human beings have also

(a) recreational interests (enjoy leisure through mountaineering, sports, and pastimes),
(b) aesthetic interests (enjoy nature as from seeing waterfalls and snow-clad mountains),
(c) scientific interests to explore into nature or processes, and
(d) A basic interest to survive, by preservation as well as conservation of nature and natural resources.

- Rights ethicists favor the basic rights to live and right to liberty, to realize the right to a live in a supportive environment.
- Further, virtue ethics stresses importance of prudence, humility, appreciation of natural beauty, and gratitude to the Mother Nature that provides everything.
- However, the nature-centered ethics, which ensures the worth of all living beings and organisms, seems to be more appropriate in the present-day context. Many Asian religions stress the unity with nature, rather than domination and exploitation.
- The Zen Buddhism calls for a simple life with compassion towards humans and other animals. Hinduism enshrines the ideal of oneness (advaitha) in and principle of ahimsa to all living beings. It identifies all the human beings, animals, and plants as divine. The eco-balance is the need of the hour and the engineers are the right experimenters to achieve this.

5.2.4. Types of concern for environment

✓ **There** are two type of concern for the environment. They are:

- **Health related concern**: Engineers can be concerned for the environment when environmental pollution poses a direct and clear threat to human health
- **Non Health related concern:** Engineers can also be concerned for the environment even with the human wealth is not directly affected.

5.2.5. World's five biggest Environmental problems

✓ **Air pollution and climate change.**

- ***Problem****:* Overloading of the atmosphere and of ocean waters with carbon. Atmospheric CO2 absorbs and re-emits infrared-wavelength radiation, leading to warmer air, soils, and ocean surface waters. But the planet would be frozen solid without this.
- Unfortunately, there's now too much carbon in the air. Burning of fossil fuels, deforestation for agriculture and industrial activities has pushed up atmospheric CO2 concentrations.
- Carbon overloading is only one form of air pollution caused by burning coal, oil, gas and wood. The World Health Organization recently estimated that one in nine deaths in 2012 were attributable to diseases caused by carcinogens and other poisons in polluted air.
- ***Solutions:*** Replace fossil fuels with renewable energy. Reforestation. Reduce emissions from agriculture. Change industrial processes.
- **Examples :** Ulan Bator in Mongolia is not only one of the coldest capitals on earth, it's also a city with massive air pollution. During the winter months, yurts like Tsegi's are heated with coal and wood which contributes up to 70 percent of the smog in the city. Air pollution in Ulan Bator is seven times higher than what is considered safe by the WHO.

✓ **Deforestation.**

- ***Problem:*** Species-rich wild forests are being destroyed, especially in the tropics, often to make way for cattle ranching, soybean or palm oil plantations, or other agricultural monocultures.
- Today, about 30 percent of the planet's land area is covered by forests - which is about half as much as before agriculture got started around 11,000 years ago. About 7.3 million hectares (18 million acres) of forest are destroyed each year, mostly in the tropics. Tropical forests used to cover about 15 percent of the planet's land area; they're now down to 6 or 7 percent. Much of this remainder has been degraded by logging or burning.
- Not only do natural forests act as biodiversity reserves, they are also carbon sinks, keeping carbon out of the atmosphere and oceans.
- ***Solutions:*** Conserve of what's left of natural forests, and restore degraded areas by replanting with native tree species.

✓ **Species extinction.**

- ***Problem:*** On land, wild animals are being hunted to extinction for bushmeat, ivory, or "medicinal" products. At sea, huge industrial fishing boats equipped with bottom-trawling or purse-seine nets clean out entire fish populations. The loss and destruction of habitat are also major factors contributing to a wave of extinction - unprecedented in that it is caused by a single species: humans. The IUCN's Red List of threatened and endangered species continues to grow.
- Not only do species inherently deserve to exist, they also provide products and "services" essential to human survival. Think bees and their pollinating prowess - necessary for growing food.
- ***Solutions***. Protecting and restoring habitats is one side of this - protecting against poaching and wildlife trade is another. This should be done in partnership

✓ **Soil degradation.**

- ***Problem:*** Overgrazing, monoculture planting, erosion, soil compaction, overexposure to pollutants, land-use conversion - there's a long list of ways that soils are being damaged. About 12 million hectares of farmland a year get seriously degraded, according to UN estimates.
- ***Solutions:*** A wide range of soil conservation and restoration techniques exist, from no-till agriculture to crop rotation to water-retention through terrace-building..

✓ **Overpopulation.**

- ***Problem:*** Human population continues to grow rapidly worldwide. Humanity entered the 20th century with 1.6 billion people; right now, we're about 7.5 billion. Estimates put us at nearly 10 billion by 2050. Growing global populations, combined with growing affluence, is putting ever greater pressure on essential natural resources, like water. Most of the growth is happening on the African continent, and in southern and eastern Asia.
- ***Solutions:*** Experience has shown that when women are empowered to control their own reproduction, and gain access to education and basic social services, the average number of births per woman drops precipitously.

5.2.6. Approaches to resolve Environmental Problems

✓ **The first approach is sometimes referred to as the "cost-oblivious approach".** In this approach, cost is not taken into account, but rather the environment is made as clean as possible. No level of environmental degradation is seen as acceptable. This approach bears a striking resemblance to rights and duty ethics. There are obvious problems with this approach. It is difficult to uphold, especially in a modern urbanized society. It is

also very difficult to enforce, since the definition of "as clean as possible" is hard to agree on, and being oblivious to cost isn't practical in any realistic situation in which there are not infinite resources to apply to a problem.

- ✓ **A second approach is based on cost–benefit analysis**, which is derived from utilitarianism. Here, the problem is analyzed in terms of the benefits derived by reducing the pollution—improvements in human health, for example—and the costs required to solve the problem. The costs and benefits are weighed to determine the optimum combination. In this approach, the goal is not to achieve a completely clean environment, but rather to achieve an economically beneficial balance of pollution with health or environmental considerations.
- ✓ **There are problems associated with the cost–benefit approach**
- ✓ First, there is an implicit assumption in cost–benefit analysis that cost is an important issue. But what is the true cost of a human life or the loss of a species or a scenic view? These values are diffi cult, if not impossible, to determine.
- ✓ Second, it is difficult to accurately assess costs and benefits, and much guesswork must go into these calculations.
- ✓ Third, this approach doesn't necessarily take into account who shoulders the costs and who gets the benefits. This is frequently a problem with the sitting of landfills and other waste dumps. The cheapest land is in economically disadvantaged areas, where people don't necessarily have the political influence, education, or money required to successfully oppose a landfill in their neighborhood. Although dumps have to go somewhere, there should be some attempt to share the costs as well as share the benefits of an environmentally questionable project.
- ✓ Finally, cost–benefit analysis doesn't necessarily take morality or ethics into account. The only considerations are costs and benefits, with no room for a discussion of whether what is being done is right or not.

5.3.Computer Ethics

5.3.1. What is computer Ethics?

- ✓ **Computer ethics is the study of ethical issues that are associated primarily with computing machines and the computing profession**
- ✓ **It is the field of applied professional ethics dealing with ethical problems forced, transformed or created by computer technology**
- ✓ Cyber ethics is the field of applied ethics that examine moral, legal and social issues in the development and use of cyber technology
- ✓ **Cyber technology refers to a broad range of technologies from stand alone computers to the cluster of networked computing., information and communication technologies**
- ✓ **Thus** computer ethics is the analysis of the nature and social impact of computer technology and the corresponding formulation and justification policies for the ethical use of such technology

5.3.2. Categories of computer ethics problems

Different types of problems are found in computer ethics.

(a) Computer as the Instrument of Unethical behavior
(b) Computer as the Object of Unethical Act
(c) Problems Related to the Autonomous Nature of Computer

(a) Computer as the Instrument of Unethical Behavior

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- ✓ Computer ethics will start with an examination of ways in which computers are used as the means for unethical behavior. Many of these uses are merely extensions to computers of other types of unethical acts.
- ✓ **Bank robbery**
  - For example, computers can be used to more efficiently steal money from a bank. A more traditional bank-robbery method is to put on a mask, hand a note to a bank teller, show your gun, and walk away with some cash. Computers can be used to make bank robbery easier to perform and harder to trace. The robber simply sits at a computer terminal—perhaps the modern equivalent of a mask—invades the bank's computer system, and directs that some of the bank's assets be placed in a location accessible to him. Using a computer, a criminal can also make it difficult for the theft to be detected and traced.
  - It is clear that from an ethical standpoint, there is no difference between a bank robbery perpetrated in person and one perpetrated via a computer, although generally the amounts taken in a computer crime far exceed those taken in an armed robbery. The difference between these two types of robbery is that the use of the computer makes the crime impersonal. The criminal never comes face to face with the victim. In addition, the use of the computer makes it easier to steal from a wide variety of people.
  - **Computers can be used to steal from an employer:** Outsiders can get into a system and steal from an institution such as a bank, or a company can use the computer to steal from its clients and customers. In these cases, the computer has only made the theft easier to carry out, but does not alter the ethical issues involved. Unfortunately, the technology to detect and prevent this type of crime greatly lags behind the computer technology available to commit it. Those seeking to limit computer crime are always playing a catch-up game.
- ✓ **Privacy**
  - Similar computer ethics issues arise with regard to privacy. It is widely held that certain information is private and cannot be revealed without consent. This includes information about individuals as well as corporate information.
  - Computers did not create the issues involved in privacy, but they certainly have intensified them. Computers make privacy more difficult to protect, since large amounts of data on individuals and corporations are centrally stored on computers where an increasing number of individuals can access it. Before we look at the ways that privacy can be abused by the use of computers.
  - By privacy, we mean the basic right of an individual to control access to and use of information about himself.
  - **Invasions of privacy can be harmful to an individual in two ways**.
    - First, the leaking of private information can lead to an individual's being harassed or blackmailed. In its simplest form, this harassment may come in the form of repeated phone calls from telemarketers who have obtained information about an individual's spending habits. The harassment might also come in the form of subtle teasing or bothering from a coworker who has gained personal knowledge of the individual. Clearly, individuals have the right not to be subjected to this type of harassment.
    - Second, personal information can also be considered personal property. As such, any unauthorized use of this information is theft. This same principle applies to proprietary information of a corporation.
- ✓ **How do computers increase the problems with privacy protection?**

- This phenomenon is most easily seen by looking at the old system of record keeping. For example, medical records of individuals were at one time kept only on paper and generally resided with the individual's physician and in hospitals where a patient had been treated. Gaining access to these records by researchers, insurance companies, or other healthcare providers was a somewhat laborious process involving searching through storage for the appropriate files, copying them, and sending them through the mail.
- Unauthorized use of this information involved breaking into the office where the files were kept and stealing them or, for those who had access to the files, secretly removing or copying the files. Both of these acts involved a substantial risk of being caught and prosecuted. Generally, these records have now been computerized. Although computerization makes the retrieval of files much easier for those with legitimate needs and reduces the space required to store the files, it also makes the unauthorized use of this information by others easier.

(b) Computer as the Object of Unethical Act

- ✓ Ethical issues also arise when computers are used for "hacking." **Hacking comes in many forms: gaining unauthorized access to a database, implanting false information in a database or altering existing information, and disseminating viruses over the Internet.**
- ✓ These activities are by no means limited to highly trained computer specialists. Many hackers are bored teenagers seeking a challenge. Computer hacking is clearly ethically troublesome. Accessing private information violates the privacy rights of individuals or corporations, even if the hacker keeps this information to himself. In extreme cases, hackers have accessed secret military information, which has obvious implications for national security. Altering information in a database, even information about you, is also ethically troubling, especially if the alteration has the intent of engaging in a fraud.
- ✓ The issuance of computer viruses is also unethical. These viruses frequently destroy data stored on computers. In extreme cases, this act could lead to deaths when hospital records or equipment are compromised, to financial ruin for individuals whose records are wiped out, or even to the loss of millions of dollars for corporations, individuals, and taxpayers, as completed work must be redone after being destroyed by a virus.
- ✓ Copyright infringement is also a concern in computer ethics. Computers and the Internet have made it easy to share music, movies, software, and other copy-righted materials. Copyright gives the creator the exclusive right to profit from his creation. The protection of copyright has become increasingly difficult as court cases related to music sharing websites such as Napster and other copycat websites have illustrated. Although computers make copyright violation easy to do and hard to detect, it is still illegal and unethical. If creators can no longer profit from their work—if their work is freely distributed without their consent—then the incentive to create will diminish, and this type of creative activity that enriches everyone's lives will diminish as well. Copying music or software without the permission of the owner of the copyright is illegal and unethical.

(c) Computers as an Engineering Tool

- Computers are an essential tool for all engineers. Most often, we use computers for writing documents using a word-processing software package. We also keep track of appointments with scheduling software, use spreadsheets to make financial calculations, databases to keep

records of our work, and use commercially available soft-ware to develop plans for how our projects will proceed. The use of these types of software is not unique to engineering—indeed, they are useful in various areas of business. Unique to engineering are two uses of computers: as design tools and as components integrated into engineered systems.

- ***Computer Design Tools***
  - Numerous software packages are available for the design of engineered devices and structures. This software includes CAD/CAM, circuit analysis, finite element analysis, structural analysis, and other modeling and analysis programs. Software also exists that is designed to aid in the process of testing engineered devices by performing tests, recording data, and presenting data for analysis. These all serve to allow an engineer to work more efficiently and to help take away some of the tedious aspects of an engineer's work. However, the use of this type of software also leads to ethical issues.
  - **For example, who is responsible when a flaw in software used to design a bridge leads to the failure of the bridge? Is it the fault of the engineer who designed the bridge? Or is it the fault of the company that designed and sold the defective software?**
  - These questions all have the same answer: Software can never be a substitute for good engineering judgment. Clearly, the engineer who uses software in the design process is still responsible for the designs that were generated and the testing that was done using a computer. Engineers must be careful to make sure that the software is appropriate to the problem being worked on, and should be knowledgeable about the limitations and applicability of a software package. Engineers must also keep up to date on any flaws that have been discovered in the software and ensure that the most recent version of the software is being used—software companies make patches and updates available, and engineers must check to make sure they have the most up-to-date version. Finally, it is important to verify the results of a computer-generated design or analysis. Sometimes it's a great idea to sit down with a piece of paper and a pencil to make sure that the output of a computer program makes sense and is giving the right answer.
    - ✓ **Integration of Computers into Engineered Systems**
    - ✓ Computers have also become a component of many engineered systems. For example, modern automobiles contain multiple computers, dedicated to specific tasks. Computers control the emissions and braking systems on automobiles and allow modern vehicles to operate more efficiently and safely. However, the ability to control aspects of system performance using software removes humans from the control loop.
    - ✓ There are numerous examples of situations in which computerized systems malfunctioned without giving the operator any indication that a problem existed. In some cases, the operator was unable to intervene to solve a problem because the software design wouldn't allow it.
    - ✓ It is essential when designing systems with embedded computers and software that engineers ensure that software is adequately tested, that humans can intervene when necessary, and that safety systems have enough hardware redundancy without relying solely on software to ensure the safe operation of the system

d. Autonomous Computers

- Other ethical concerns arise because of the increasingly autonomous nature of computers. **Autonomy refers to the ability of a computer to make decisions without the intervention of humans.**
- **Some of the negative implications of this autonomy are chillingly spelled out in 2001:** A Space Odyssey, by Arthur C. Clarke, in which an autonomous computer

responsible for running a spaceship headed for Jupiter begins to turn against the humans it was designed to work for.

- **Certainly, there are applications for which autonomy is valuable**. For example, manufacturing processes that require monitoring and control at frequent intervals can greatly benefit from autonomous computers. In this case, the autonomy of the computer has very little impact beyond the interests of the manufacturer.
- **Other autonomous computer applications are not so caring**. For example, by the 1980s, computers were widely used to automate trading on the major U.S. stock exchanges. Some brokerages and institutional investors utilized computers that were programmed to sell stocks automatically under certain conditions, among them when prices drop sharply. This type of programming creates an unstable situation. As prices drop, computers automatically start selling stocks, further depressing the prices, causing other computers to sell, and so on until there is a major market crash.
- **Autonomy of computer systems has also been called into question with regard to military weapons.** Many weapons systems rely heavily on computer sensors and computer controls. Due to the speed with which events can happen on a modern battlefield, it would seem valuable to have weapons that can operate autonomously.
- However, weapons systems operating without human intervention can suffer from the instability problems described with regard to the financial markets. For example, a malfunctioning sensor might lead a computer to think that an enemy has increased its military activity in a certain area. This would lead to an increased activity by the enemy, etc. This unstable situation could lead to a conflict and loss of life when really there was nothing happening. This problem is of special concern due to the implications for the loss of human life. It is clear from this example that **although autonomous computers can greatly increase productivity and efficiency in many areas, ultimately there must be some human control in order to prevent disasters.**

5.3.3. Computer code of Ethics

The Ten Commandments of computer code of ethics are:

1. Thou shalt not use a computer to harm other people.
2. Thou shalt not interfere with other people's computer work.
3. Thou shalt not snoop around in other people's computer files.
4. Thou shalt not use a computer to steal.
5. Thou shalt not use a computer to bear false witness.
6. Thou shalt not copy or use proprietary software for which you have not paid (without permission).
7. Thou shalt not use other people's computer resources without authorization or proper compensation.
8. Thou shalt not appropriate other people's intellectual output.
9. Thou shalt think about the social consequences of the program you are writing or the system you are designing.
10. Thou shalt always use a computer in ways that ensure consideration and respect for your fellow humans.

5.4.Weapons Development

Military activities including the world wars have stimulated the growth of technology. The growth of Internet amply illustrates this fact. The development of warfare and the involvement of engineers bring out many ethical issues concerned with engineers, such as the issue of integrity in experiments as well as expenditure in defense research and development, issue of personal commitment and conscience, and the issues of social justice and social health.

Engineers involve in weapons development because of the following reasons:

- ✓ It gives one job with high salary.
- ✓ One takes pride and honor in participating in the activities towards the defense of the nation (patriotic fervor).
- ✓ One believes the he fights a war on terrorism and thereby contribute to peace and stability of the country. Ironically, the wars have never won peace, only peace can win peace!
- ✓ By research and development, the engineer is reducing or eliminating the risk from enemy weapons, and saving one's country from disaster.
- ✓ By building-up arsenals and show of force, a country can force the rogue country, towards regulation. Engineers can participate effectively in arms control negotiations for surrender or peace, e.g., bombing of Nagasaki and Hiroshima led to surrender by the Japanese in 1945.

5.4.1. Involvement in Weapons Work

- ✓ Historically, a quick death in battle by sword was considered acceptable, whereas the use of remote weapons (from bow and arrow to firearms) was frequently condemned as cowardly, devoid of courage, and equivalent to plain murder.
- ✓ As modern weapons of war progressed through catapults, cannons, machine guns, and bombs released from airplanes and missiles to reach further and further, the soldiers firing them were less likely to see the individual human beings—soldiers as well as civilians—they had as their general target. The continuing automation of the battle scene tends to conceal the horrors of war and thus makes military activity seem less threatening and high-tech wars more appealing.
- ✓ For some engineers, involvement in weapons development conflicts with personal conscience; for others, it is an expression of conscientious participation in national defense.
- ✓ **The following cases illustrate the kinds of moral issues involved in deciding whether to engage in military work.**

1. Bob himself does not handle the bombs in any way, but as an industrial engineer he enables the factory to run efficiently. He does not like to be involved in making weapons, but then he tells himself that someone has to produce them. If he does not do his job, someone else will, so nothing would change. Further-more, with the cost of living being what it is, he owes his family a steady income.

2. Mary is a chemical engineer. A promotion has gotten her into napalm manufacturing. She knows it is nasty stuff, having heard that the Nobel laureate, Professor Wald of Harvard University, was said to have berated the chemical industry for producing this "most brutal and destructive weapon that has ever been created." She saw a scary old photograph from the Vietnam War period, depicting a badly burned peasant girl running from a village in flames. She hates war like most human beings, but she feels that the government knows more than she does about international dangers and that the present use of napalm by U.S. forces in Iraq may be unavoidable. But Mary knows that if she continues to do well on her job she will be promoted, and one of these days she may well be in the position to steer the company into the production of peaceful products.

3. Ron is a specialist in missile control and guidance. He is proud to be able to help his country through his efforts in the defense industry, especially as part of the "war on terrorism." The missiles he works on will carry single or multiple warheads with the kind of dreadful firepower which, in his estimation, has kept any potential enemy in

check since 1945. At least there has not been another world war—the result of mutual deterrence, he believes.

4. Marco's foremost love is physical electronics. He works in one of the finest laser laboratories. Some of his colleagues do exciting research in particle beams. That the laboratory is interested in developing something akin to the "death ray" described by science fiction writers of his youth is of secondary importance. More bothersome is the secrecy that prevents him from freely exchanging ideas with experts across the world.
5. Joanne is an electronics engineer whose work assignment includes avionics for fighter planes that are mostly sold abroad. She has no doubts about such planes going to what she considers friendly countries, but she draws the line at their sale to potentially hostile nations. Joanne realizes that she has no leverage within the company, so she occasionally alerts journalist friends with news she feels all citizens should have.
6. Ted's background and advanced degrees in engineering physics gave him a ready entry into nuclear bomb development. As a well-informed citizen he is seriously concerned with the dangers of the ever-growing nuclear arsenal. He is also aware of the possibilities of an accidental nuclear exchange. In the mean-time he is working hard to reduce the risk of accidents such as the 32 "broken arrows" (incidents when missile launchings may have occurred erroneously) that had been reported by the Pentagon during the height of the Cold War, or the many others that he knows have occurred worldwide. Ted continues in his work because he believes that only specialists, with firsthand experience of what modern weapons can do, can eventually turn around the suicidal trend represented by their development.

5.4.2. Role of Engineers in Defense Industry

- ✓ Defense industry is one of the areas, which provide number of jobs opportunities to engineers. Engineers are capable of innovating and developing new weapons. Weapons are designed for one purpose – to kill human beings
- ✓ On the one hand, many of the rational engineers feel that they cannot work on designing weapons, which are ultimately used to kill the human beings. Even though they are not the ultimate users of those weapons, they find it morally unacceptable to work on such areas
- ✓ On the other hand, similar morally responsible engineers feel that working in defense industry is ethical. Because they feel it as honor to work for their nation / Government.
- ✓ In fact, the above two different views about working in defense industry are well justified by various ethical theories
- ✓ Also the engineers should not be attracted by incentives and advancements that are being offered in the defensive industries, they must have the potential judgments to serve in defense works that would expose the human community.

Defense Industry Problems

Many nations give privileges to defense industry, without even thinking, on serious problems that arise in large military build-ups. **Some of the problems are:**

- ✓ The problem of waste and cost overruns is a continuing one in the defense industry.
- ✓ Another problem faced by the defense industry is the technology creep. It refers to the development of new weapons, such as the cruise missile, which can change diplomatic arrangements even as they are being negotiated. Thus it affects the political stability of a country
- ✓ Secrecy creates problems for the defense industry. If the secrets of planned funding were leaked to prospective contractors, then it may lead to high cost and poor quality of defense materials and weapons

- ✓ Many countries allocate funds for the defense sector than that of the other public welfare schemes

5.5. Engineers as Managers

5.5.1. Why do most of the Engineers move into Managerial Roles?

- ✓ **Engineers move into management roles, because of the following two reasons**
  - ✓ Much corporate management prefer Engineers as their Managers. Because they believe that:
    - To manage technological corporation, the technical understanding is necessary and
    - The engineers have potential of understanding the business techniques of any corporate bodies than any non engineers. Also it is comparatively easier to teach the business techniques than to teach non engineers the engineering techniques
  - ✓ Engineers are attracted by various corporate incentives such as higher pay, greater authority, wider responsibility and increased prestige and recognition.

5.5.2. Managers As Professions

Mintzberg published his Ten Management Roles in his book, "Mintzberg on Management: Inside our Strange World of Organizations," in 1990.

The ten roles are:

1. Figurehead, 2. Leader 3. Liaison 4. Monitor 5. Disseminator	6. Spokesperson 7. Entrepreneur 8. Disturbance Handler 9. Resource Allocator 10. Negotiator

The 10 roles are then divided up into three categories, as follows:

Category	Roles
Interpersonal	Figurehead Leader Liaison
Informational	Monitor Disseminator Spokesperson

Interpersonal Category

The managerial roles in this category involve **providing** information and ideas.

1. **Figurehead** – As a manager, you have social, ceremonial and legal responsibilities. You're expected to be a source of inspiration. People look up to you as a person with authority, and as a figurehead.
2. **Leader** – This is where you provide leadership for your team, your department or perhaps your entire organization; and it's where you manage the performance and responsibilities of everyone in the group.
3. **Liaison** – Managers must communicate with internal and external contacts. You need to be able to network effectively on behalf of your organization.

Informational Category

The managerial roles in this category involve **processing** information.

4. **Monitor** – In this role, you regularly seek out information related to your organization and industry, looking for relevant changes in the environment. You also monitor your team, in terms of both their productivity, and their well-being.
5. **Disseminator** – This is where you communicate potentially useful information to your colleagues and your team.
6. **Spokesperson** – Managers represent and speak for their organization. In this role you're responsible for transmitting information about your organization and its goals to the people outside it.

Decisional Category

The managerial roles in this category involve **using** information.

7. **Entrepreneur** – As a manager, you create and control change within the organization. This means solving problems, generating new ideas, and implementing them.
8. **Disturbance Handler** – When an organization or team hits an unexpected roadblock, it's the manager who must take charge. You also need to help mediate disputes within it.
9. **Resource Allocator** – You'll also need to determine where organizational resources are best applied. This involves allocating funding, as well as assigning staff and other organizational resources.
10. **Negotiator** – You may be needed to take part in, and direct, important negotiations within your team, department, or organization.

5.5.3. Impact of transition on ethical issues

- ✓ Generally managers are changed for
  a) Merely serving for narrow interests of the corporation
  b) Their objective of increasing the firm's profit only
  c) Not bothering about others responsibilities to promote the public good
- ✓ According to Friedman, manager's ethics is limited only to the responsibility to maximize profits for stockholders. But Engineers ethics involve wider responsibilities to protect the public safety, health and welfare of the public.
- ✓ In contrast to Friedman's view, it is recognized that the morals roles of engineers are complementary and symbiotic, they are associated with each other
- ✓ As a manager, engineers remain professionals whose primary responsibility is to provide useful products and services while ensuring that they are safe and profitable

5.5.4. Characteristics

The characteristics of engineers as managers are:

a) Promote an ethical climate, through framing organization policies, responsibilities and by personal attitudes and obligations.
b) Resolving conflicts, by evolving priority, developing mutual understanding, generating various alternative solutions to problems.
c) Social responsibility to stakeholders, customers and employers. They act to develop wealth as well as the welfare of the society. Ethicists project the view that the manager's responsibility is only to increase the profit of the organization, and only the engineers have the responsibility to protect the safety, health, and welfare of the public. But managers have the ethical responsibility to produce safe and good products (or useful service), while showing respect for the human beings who include the employees, customers and the public. Hence, the objective for the managers and engineers is to produce valuable products that are also profitable.

5.5.5. Responsibilities an Ethical Climate

There are two important responsibilities of engineer – managers. They are:

1. **Promoting an Ethical Climate**

What is meant by an ethical climate?

- ✓ A favorable working atmosphere required to achieve a morally responsible conduct is called an ethical climate
- ✓ Several factors such as nature of organization, informal traditions and practices and personal attitudes directly contribute to the ethical climate

What are the defining features of an ethical corporate climate?

- ✓ Ethical values should be widely acknowledged and appreciated by all the managers and employees of a company
- ✓ The use of proper ethical language like code of ethics should be recognized as a legitimate part of the company
- ✓ The top management should accomplish a moral voice in both words and policies and also by personal example, in other words the top level management has to enhance confidence that the company is more serious about ethics
- ✓ There should be some procedures for confronting and resolving conflicts

2. **Resolving/ Managing Conflicts**

In solving conflicts, force should not be resorted. In fact, the conflict situations should be tolerated, understood, and resolved by participation by all the concerned. The conflicts in case of project managers arise in the following manners:

a) Conflicts based on schedules: This happens because of various levels of execution, priority and limitations of each level.
b) Conflicts arising out of fixing the priority to different projects or departments. This is to be arrived at from the end requirements and it may change from time to time.
c) Conflict based on the availability of personnel.
d) Conflict over technical, economic, and time factors such as cost, time, and performance level.
e) Conflict arising in administration such as authority, responsibility, accountability, and logistics required.
f) Conflicts of personality, human psychology and ego problems.
g) Conflict over expenditure and its deviations.

Most of the conflicts can be resolved by following the principles listed here:

People

Separate people from the problem. It implies that the views of all concerned should be obtained. The questions such as what, why, and when the error was committed is more important than to know who committed it. This impersonal approach will lead to not only early solution but also others will be prevented from committing errors.

Interests

Focus must be only on interest i.e., the ethical attitudes or motives and not on the positions (i.e., stated views). A supplier may require commission larger than usual prevailing rate for an agricultural product. But the past analysis may tell us that the material is not cultivated regularly and the monsoon poses some additional risk towards the supply. Mutual interests must be respected to a maximum level. What is right is more important than who is right!

Options

Generate various options as solutions to the problem. This helps a manager to try the next best solution should the first one fails. Decision on alternate solutions can be taken more easily and without loss of time.

Evaluation

The evaluation of the results should be based on some specified objectives such as efficiency, quality, and customer satisfaction. More important is that the means, not only the goals, should be ethical.

5.6.CODES OF ETHICS

5.6.1. National Society of Professional Engineers

I. Fundamental Canons

Engineers in the fulfilment of their professional duties shall

1. Hold paramount the safety, health, and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honourably, responsibly, ethically, and lawfully so as to enhance the honour, reputation, and usefulness of the profession.

II. Rules of Practice

1. **Engineers shall hold paramount the safety, health, and welfare of the public.**

a) If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.

b) Engineers shall approve only those engineering documents that are in conformity with applicable standards.

c) Engineers shall not reveal facts, data, or information without prior consent of the client or employer except as authorized or required by law or this code.

d) Engineers shall not permit the use of their name or associate in business ventures with any person or firm that they believe are engaged in fraudulent or dishonest enterprise.

e) Engineers shall not aid or abet the unlawful practice of engineering by a person or firm.

f) Engineers having knowledge of any alleged violation of this Code shall report thereon to appropriate professional bodies and when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required.

2. Engineers shall perform services only in the areas of their competence.

a) Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.

b) Engineers shall not affix their signatures to any plans or documents dealing with the subject matter in which they lack competence, nor to any plan or document not prepared under their direction and control.

c) Engineers may accept assignments and assume responsibility for coordination of an entire project and sign and seal the engineering documents for the entire project, provided that each technical segment is signed and sealed only by the qualified engineers who prepared the segment.

3. Engineers shall issue public statements only in an objective and truthful manner.

a) Engineers shall be objective and truthful in professional reports, statements, or testimony.

b) They shall include all relevant and pertinent information in such reports, statements, or testimony, which should bear the date indicating when it was current.

c) Engineers may express publicly technical options that are founded upon knowledge of the facts and competence in the subject matter.
d) Engineers shall issue no statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties on prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking and by revealing the existence of any interest the engineers may have in the matters.

4. Engineers shall at for each employer or client as faithful agents or trustees

a) Engineers shall disclose all known or potential conflicts of interest that could influence or appear to influence their judgment or the quality of their services.
b) Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed and agreed to by all interested parties.
c) Engineers shall not solicit or accept financial or other valuable consideration, directly or indirectly, from outside agents on connection with the work for which they are responsible.
d) Engineers in public service as members, advisers, or employees of a governmental or quasi- governmental body or department shall not participate in decisions with respect to services solicited or provided by them or their organizations in private or public engineering practice.
e) Engineers shall not solicit or accept a contract from a governmental body on which a principal or officer of their organization serves as a member.

5. Engineers shall avoid deceptive acts

a) Engineers shall not falsify their qualifications or permit misrepresentation of their or their associate's qualifications. They shall not misrepresent or exaggerate their responsibility in or for the subject matter of prior assignments. Brochures or other presentations incident to the solicitation of employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint ventures, or past accomplishments.
b) Engineers shall not offer, give, solicit or receive, either directly or indirectly, any contribution to influence the award of a contract by public authority, or which may be reasonably construed by the public as having the effect of intent to influence the awarding of a contract. They shall not offer any gift or other valuable consideration in order to secure work. They shall not pay a commission, percentage, or brokerage fee in order to secure work, except to a bonafide employee or established commercial or marketing agencies retained by them.

III. Professional Obligations

1. **Engineers shall be guided in all their relation by the highest standards of honesty and integrity.**

a) Engineers shall acknowledge their errors and shall not distort or alter the facts.
b) Engineers shall advice their clients or employers when they believe a project will not be successful.
c) Engineers shall not accept outside employment to the detriment of their regular work or interest. Before accepting any outside engineering employment they will notify their employers.
d) Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.
e) Engineers shall not promote their own interest at the expense of the dignity and integrity of the profession.

2. **Engineers shall at all times strive to serve the public interest.**
   a) Engineers shall seek opportunities to participate in civic affairs, career guidance for youths, and work for the advancement of the safety, health, and well-being of their community.
   b) Engineers shall not complete, sign, or seal plans and/or specifications that are not in conformity with applicable engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.
   c) Engineers shall endeavour to extend public knowledge and appreciation of engineering and its achievements.

3. **Engineers shall avoid all conduct or practice that deceives the public.**
   a) Engineers shall avoid the use of statements containing a material misrepresentation of fact or omitting a material fact.
   b) Consistent with the foregoing, engineers may advertise for recruitment of personnel.
   c) Consistent with foregoing, engineers may prepare articles for the lay or technical press, but such articles shall not imply credit to the author for work performed by other.

4. **Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.**
   a) Engineers shall not, without the consent of all interested parties, promote or arrange for new employment or practice in connection with a specific project for which the engineer has gained particular and specialized knowledge.
   b) Engineers shall not, without the consent of all interested parties, participate in or represent in adversary interest in connection with a specific project or proceeding in which the engineer has gained particular specialized knowledge on behalf of a former client or employer.

5. **Engineers shall not be influenced in their professional duties by conflicting interests.**
   a) Engineers shall not accept financial or other consideration including free engineering designs, from material or equipment suppliers for specifying their product.
   b) Engineers shall not accept commission or allowances, directly or indirectly, from contractors or other parties dealing with clients or employers of the engineer in connection with work for which the engineer is responsible.

6. **Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper methods.**
   a) Engineers shall not request, propose, or accept a commission on a contingent basis under circumstances in which their judgement may be compromised.
   b) Engineers in salaried positions shall accept part-time engineering work only to the extent consistent with policies of the employer and in accordance with ethical consideration.
   c) Engineers shall not, without consent, use equipment, supplies, laboratory, or office facilities of an employer to carry on outside private practice.

7. **Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall resent such information to the proper authority for action.**
   a) Engineers in private practice shall not review the work of another engineer for the same client, except with the knowledge of such engineer, or unless the connection of such engineer with the work has been terminated.

b) Engineers in governmental, industrial, or educational employment are entitled to review and evaluate the work of other engineers when so required by their employment duties.
c) Engineers in sales or industrial employ are entitled to make engineering comparisons or represented products with products of other suppliers.

8. **Engineers shall accept personal responsibility for their professional activities, provided, however, the engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected.**

a) Engineers shall conform to state registration laws in the practice of engineering.
b) Engineers shall not use association with a non-engineer, a corporation, or partnership as a 'cloak' for unethical acts.

9. **Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.**

a) Engineers shall, whenever possible, name the person or persons who may be individually responsible for designs, inventions, writings, or other accomplishments.
b) Engineers using designs supplied by a client recognize that the designs remain the property of the client and may not be duplicated by the engineer for others, without the express permission.
c) Engineers before undertaking work for others in connection with which the engineer may make improvements, plans, designs, inventions, or other records that may justify copyrights or patents, should enter into a positive agreement regarding ownership.
d) Engineers' designs, data, records, and notes referring exclusively to an employer's work are the employer's property. The employer should indemnify the engineer for use of the information for any purpose other than the original purpose.
e) Engineers shall continue their professional development throughout their careers and should keep current in their specialty fields by engaging in professional practice, participating in continuing education course, reading in the technical literature, and attending professional meetings and seminars.

5.6.2. The Institute of Electrical & Electronics Engineers

Code of Ethics

We the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. To accept responsibility in making engineering decisions consistent with the safety, health and welfare of the public, and to disclose prompt factors that might endanger the public or the environment.
2. To avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist.
3. To be honest and realistic in stating claims or estimates based on available data.
4. To reject bribery in all its forms.
5. To improve the understanding of technology, its appropriate application, and potential consequences.
6. To maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations.
7. To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others.

8. To treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin.
9. To avoid injuring others, their property, reputation, or employment by false or malicious action.
10. To assist colleagues and co-workers in their professional development and to support them in following code of ethics.

5.6.3. Institution of Engineers (India)

Code of Ethics (Effective from March 2004)

The corporate members if the IEI are committed to promote and practice the profession of engineering for the common good of the community bearing in mind the following concerns:

1. The ethical standard
2. Social justice, social order, and human rights
3. Protection of the environment
4. Sustainable development
5. Public safety and tranquility

The Tenets of the Code of Ethics

A corporate member

1. Shall utilize his/her knowledge and expertise for the welfare, health, and safety of the community without any discrimination for sectional or private interests.
2. Shall maintain the honour, integrity and dignity in all his professional actions to be worthy of the trust of the community and the profession.
3. Shall act only in the domains of his competence and with diligence, care, sincerity and honesty.
4. Shall apply his knowledge and expertise in the interest of his employer or the clients for whom he shall work without compromising with other obligations to these tenets.
5. Shall not falsify or misrepresent his own or his associates qualification, experience etc.
6. Wherever necessary and relevant, shall take all reasonable steps to inform, himself, his employer or clients, of the environmental, economic, social and other possible consequences, which may arise out of his actions.
7. Shall maintain utmost honesty and fairness in making a statement or giving witness and shall do so on the basis of adequate knowledge.
8. Shall not directly or indirectly injure the professional reputation of another member.
9. Shall reject any kind of offer that may involve unfair practice or may cause avoidable damage to the eco-system.
10. Shall be concerned about and shall act in the best of his abilities for maintenance of sustainability of the process of development.
11. Shall not act in any manner which may injure the reputation of the institution or which may cause any damage to the institution financially or otherwise.

5.6.4. Indian Institute of Material Management

Code of Ethics

1. To consider first the total interest of one's organization in all transactions without impairing the dignity and responsibility to one's office.
2. To buy without prejudice seeking to obtain the maximum ultimate value for each rupee of expenditure.
3. To subscribe and work for honesty and truth in buying and selling.
4. To denounce all forms and manifestations of commercial bribery and to eschew anti-social practices.

5. To respect one's obligations and those of one's organization consistent with good business practice.

5.6.5. Institution of Electronics and Telecommunication Engineers

Code of Ethics

1. A corporate member will, at all times, endeavour to protect the engineering profession from misrepresentation and misunderstanding.
2. A corporate member will interact with others in his profession by free exchange of information and experience. He will contribute to the growth of the institution to maximum effectiveness to the best of his ability.
3. A corporate member will not offer his professional services by advertisement or through any commercial advertising media, or solicit engineering work, trading, teaching either directly or indirectly or through agencies/organizations in any manner derogatory to the dignity of the profession and the institution.
4. A corporate member will not directly or indirectly injure the professional reputation, work, or practice of another corporate member.
5. A corporate member will not divulge confidential findings or actions of the council or committee of which he is a member, without obtaining official clearance.
6. A corporate member will not take credit for an activity, professional work, engineering proposal when engaged in a team and give due recognition to those where due.
7. A corporate member will express an opinion only when it is founded on facts and honest conviction before a forum, court, commission or at an inquiry.
8. A corporate member will exercise due restraint in criticizing the work or professional conduct of another corporate member which would impinge or hurt his character and reputation.
9. A corporate member will not try to supplant another corporate member in a particular employment, office or contract.
10. A corporate member will be upright in all his dealings with person(s), organizations, in business, contractors, and agencies. He should not take actions that lead to groupisim, political connotation or unethical conduct in the discharge if his official powers.
11. A corporate member will not misrepresent his qualification to gain undue advantage in his profession.
12. A corporate member will act with fairness and justice in any office, employment or contract.
13. A corporate member will not associate in engineering work which does not conform to ethical practices.
14. A corporate member will not compete unfairly with another corporate member by means, which in the opinion of others, are based on garnering support for personal gain, enlisting uncalled for sympathy, espousing unjust cases or amounts to use of unconstitutional methods.
15. A corporate member will act in professional matters as a faithful agent or trustee.
16. A corporate member will not receive remuneration, commission, discount or any indirect profit from any work with which he is entrusted, unless specifically so permitted.
17. A corporate member will not accept financial or other compensation from more than one source for the same service or work connected thereto, unless so authorized
18. A corporate member will immediately inform his organisation/institution of any financial interest in a business, and engineering work which may compete with, adversely affect or hamper the growth of parent body.

19. A corporate member will engage or enlist the services of specialist/experts when in his judgement, such services are in the best interest of his employer or to the profession.
20. A corporate member will endeavour to develop a team among his colleagues and staff and provide equal opportunity to them for professional development and advancement.
21. A corporate member will subscribe to the principle of appropriate norms, appreciation and adequate compensation for those engaged in office, technical and professional employment including those in subordinate positions.
22. A corporate member, if he considers that another corporate member is guilty of unethical, illegal, unfair practice, defalcation, will not present such information to the Council of the Institution for necessary action, unless armed with substantial proof.

5.7.Engineers As Consultants

- Consultants are persons who give expert advice in Engineering, business, law etc.
- Consulting engineers generally exercise their consulting activities as independent. The consulting engineers work in private. There is no salary from the employers. But they charge fees from the sponsor and they have more freedom to decide on their projects. Still they have no absolute freedom, because they need to earn for their living. The consulting engineers have ethical responsibilities different from the salaried engineers, as follows:
    1. Advertising
    2. Competitive bidding
    3. Contingency fees
    4. Safety and client needs
    5. Provisions for resolution of disputes

1. Advertising

- ✓ The consulting engineers are directly responsible for advertising their services, even if they employ other consultants to assist them. But in many organizations, this responsibility is with the advertising executives and the personnel department.
- ✓ They are allowed to advertise but to avoid deceptive ones. Deceptive advertising such as the following are prohibited:
    a) By white lies.
    b) Half-truth, e.g., a product has actually been tested as prototype, but it was claimed to have been already introduced in the market. An architect shows the photograph of the completed building with flowering trees around but actually the foundation of the building has been completed and there is no real garden.
    c) Exaggerated claims. The consultant might have played a small role in a well-known project.
    d) But they could claim to have played a major role.
    e) Making false suggestions. The reduction in cost might have been achieved along with the reduction in strength, but the strength details are hidden.
    f) Through vague wordings or slogans.

2. Competitive Bidding

- ✓ **It means process of offering of prices at an auction or in business, and get something in return for the service offered.** The organizations have a pool of engineers.
- ✓ The expertise can be shared and the bidding is made more realistic. But the individual consultants have to develop creative designs and build their reputation steadily and carefully, over a period of time.

- ✓ The clients will have to choose between the reputed organizations and proven qualifications of the company and the expertise of the consultants. Although competent, the younger consultants are thus slightly at a disadvantage.

3. Contingency Fee

- ✓ This is the fee or commission paid to the consultant, when one is successful in saving the expenses for the client. A sense of honesty and fairness is required in fixing this fee.
- ✓ The NSPE Code III says that the engineers shall not propose or accept a commission on a contingent basis where their judgment may be compromised.
- ✓ The fee may be either as an agreed amount or a fixed percentage of the savings realized. But in the contingency fee-agreements, the judgment of the consultant may be biased.
- ✓ The consultant may be tempted to specify inferior materials or design methods to cut the construction cost. This fee may motivate the consultants to effect saving in the costs to the clients, through reasonably moral and technological means.

4. Safety and Client's Needs

- ✓ The greater freedom for the consulting engineers in decision making on safety aspects, and difficulties concerning truthfulness are the matters to be given attention.
- ✓ For example, in design-only projects, the consulting engineers may design something and have no role in the construction. Sometimes, difficulties may crop-up during construction due to non-availability of suitable materials, some shortcuts in construction, and lack of necessary and adequate supervision and inspection.
- ✓ Properly-trained supervision is needed, but may not happen, unless it is provided. Further, the contractor may not understand and/or be willing to modify the original design to serve the clients best.
- ✓ A few on-site inspections by the consulting engineers will expose the deficiency in execution and save the workers, the public, and the environment that may be exposed to risk upon completion of the project.
- ✓ The NSPE codes on the advertisement by consultants provide some specific regulations. The following are the activities prohibited in advertisement by consultant:
    1. The use of statement containing misrepresentation or omission of a necessary fact.
    2. Statement intended or likely to create an unjustified expectation.
    3. Statement containing prediction of future (probable) success.
    4. Statement intended or likely to attract clients, by the use of slogans or sensational language format.

5. Provision of resolution of disputes

- ✓ Since large engineering projects require responsibilities from different values within the organization representing owner, the consulting engineer and the construction company, therefore it is obvious that there may be chances for overlapping responsibilities, misplaced control, indecision, delays and inability to solve disputes quickly
- ✓ Filling litigation cases against consulting engineers has increased considerably
- ✓ As these cases are time consuming, costly and laborious process, therefore the consulting engineer should be prepared to have contractual provisions to resolve conflicts

5.8.Engineers As Expert Witness

- ✓ Frequently engineers are required to act as consultants and provide expert opinion and views in many legal cases of the past events.
    - o They are required to explain the causes of accidents, malfunctions and other technological behaviour of structures, machines, and instruments, e.g., personal

injury while using an instrument, defective product, traffic accident, structure or building collapse, and damage to the property, are some of the cases where testimonies are needed. The focus is on the past.

- Public planning, policy making that involves technology.

✓ Usually engineers are hired by one adversary in the dispute. These engineers releases special ethical concerns

✓ It is desired that without becoming hired guns, engineers can function as advocates for attorneys and their clients, for public officials, or for private organisation that hire them

5.8.1. Engineers As Expert Witness In The Courts

✓ The dependent in civil or criminal cases may hire an engineer to serve as an expert witness

✓ Some engineers may serve as experts and some may specialist in forensic engineering. Forensic engineering means the application of engineering skills and knowledge in criminal investigation to aid judicial system

✓ Engineers may act as witness in a wide variety of cases such as concerning defective products, personal injury, damage to properties, traffic accidents and airplane crashes

✓ Engineer's evidences are considered seriously while awarding compensatory damages for injuries, loss of property or violation of rights

✓ **The functions of eye-witness vs. expert-witness**

Eye-witness	*Expert-witness*
1. Eye-witness gives evidence on only what has been seen or heard actually (perceived facts)	1. Gives expert view on the facts in their area of their expertise 2. Interprets the facts, in term of the cause and effect relationship 3. Comments on the view of the opposite side 4. Reports on the professional standards, especially on the precautions when the product is made or the service is provided

5.8.2. Abuses of Engineers As Expert witness

✓ **<u>The engineers, who act as expert-witnesses, are likely to abuse their positions in the following manners:</u>**

✓ ***Hired Guns***

- Mostly lawyers hire engineers to serve the interest of their clients. Lawyers are permitted and required to project the case in a way favorable to their clients. But the engineers have obligations to thoroughly examine the events and demonstrate their professional integrity to testify only the truth in the court.
- They do not serve the clients of the lawyers directly. The hired guns forward white lies and distortions, as demanded by the lawyers. They even withhold the information or shade the fact, to favor their clients.

✓ ***Money Bias***

- Consultants may be influenced or prejudiced for monitory considerations, gain reputation and make a fortune.

✓ ***Ego Bias***

✓ The assumption that the own side is innocent and the other side is guilty, is responsible for this behavior.

- ✓ An inordinate desire to serve one's client and get name and fame is another reason for this bias.
- ✓ ***Sympathy Bias***
- ✓ Sympathy for the victim on the opposite side may upset the testimony. The integrity of the consultants will keep these biases away from the justice.
- ✓ The court also must obtain the balanced view of both sides, by examining the expert witnesses of lawyers on both sides, to remove a probable bias.
- ✓ **Duties**

1. The expert-witness is required to exhibit the responsibility of *confidentiality* just as they do in the consulting roles. They can not divulge the findings of the investigation to the opposite side, unless it is required by the court of law.
2. More important is that as witness they are *not required to volunteer* evidence favorable to the opponent. They must answer questions truthfully, need not elaborate, and remain neutral until the details are asked for further.
3. They should be *objective* to discover the truth and communicate them honestly.
4. The stand of the experts depends on the *shared understanding* created within the society. The legal system should be respected and at the same time, they should act in conformance with the professional standards as obtained from the code of ethics.
5. The experts should earnestly be *impartial* in identifying and interpreting the observed data, recorded data, and the industrial standards. They should not distort the truth, even under pressure. Although they are hired by the lawyers, they do not serve the lawyers or their clients. They serve the justice. Many a time, their objective judgments will help the lawyer to put up the best defense for their clients.

5.9. Engineers As Expert Advisors

5.9.1. Advisors In Planning And Policy Making

Advisors

- The engineers are required to give their view on the future such as in planning, policy-making, which involves the technology. For example, should India expand nuclear power options or support traditional energy sources such as fossil fuels or alternative forms like solar and wind energy? In the recent past, this topic has created lot of fireworks, in the national media.

<u>Various issues and requirements for engineers who act as advisors are:</u>

1. Objectivity

The engineers should study the cost and benefits of all possible alternative means in objective manner, within the specified conditions and assumptions.

2. Study All Aspects

They have to study the economic viability (effectiveness), technical feasibility (efficiency), operational feasibility (skills) and social acceptability, which include environmental and ethical aspects, before formulating the policy.

3. Values

Engineers have to possess the qualities, such as (*a*) honesty, (*b*) competence (skills and expertise), (*c*) diligence (careful and alert) (*d*) loyalty in serving the interests of the clients and maintaining confidentiality, and (*e*) public trust, and respect for the common good, rather than serving only the interests of the clients or the political interests.

4. Technical Complexity

The arbitrary, unrealistic, and controversial assumptions made during the future planning that are overlooked or not verified, will lead to moral complexity. The study on future is full of uncertainties than the investigations on the past events. On the study of energy options, for

example, assumptions on population increase, life style, urbanization, availability of local fossil resources, projected costs of generating alternative forms of energy, world political scenario, world military tensions and pressures from world organizations such as World Trade Organisation (W.T.O.) and European Union (EU) may increase the complexity in judgment on future.

5. National Security

The proposed options should be aimed to strengthen the economy and security of the nation, besides safeguarding the natural resources and the environment from exploitation and degradation.

5.9.2. Normative Models of Advisors

For the advisors on policy making or planning, a shared understanding on balancing the conflicting responsibilities, both to the clients and to the public, can be effected by the following roles or models:

1. Hired Gun

The prime obligation is shown to the clients. The data and facts favourable to the clients are highlighted, and unfavourable aspects are hidden or treated as insignificant. The minimal level of interest is shown for public welfare.

2. Value-neutral Analysts

This assumes an impartial engineer. They exhibit conscientious decisions, impartiality i.e., without bias, fear or favour, and absence of advocacy.

3. Value-guided Advocates

The consulting engineers remain honest (frank in stating all the relevant facts and truthful in interpretation of the facts) and autonomous (independent) in judgement and show paramount importance to the public (as different from the hired guns).

5.9.3. Core Qualities Required for an Expert Advisors

According to Rosemarie Tong, an engineer should have following virtues

- **Honesty – the quality of being truthfulness**
- **Competence – the thorough Knowledge of the work they undertake to do**
- **Diligence – to carry out the given tasks carefully and promptly**
- **Loyalty – the quality of being true and faithful in one's support**

5.10. Moral Leadership

Engineers provide many types of leadership in the development and implementation of technology, as managers, entrepreneurs, consultants, academics and officials of the government. Moral leadership is not merely the dominance by a group. It means adopting reasonable means to motivate the groups to achieve morally desirable goals. This leadership presents the engineers with many challenges to their moral principles.

5.10.1. Moral creative Leaders

- The success of corporation is to a greater extent is influenced by the quality of leadership
- According to Barnard "**Leadership refers to the quality of the behaviour of the individuals where by, they guide people on their activities in organized effort"**
- **Moral leadership is essentially required for the engineers, for the reasons listed as follows:**

1. It is leading a group of people towards the achievement of global and objectives. The goals as well as the means are to be moral. For example, Hitler and Stalin were leaders, but only in an instrumental sense and certainly not on moral sense.
2. The leadership shall direct and motivate the group to move through morally desirable ways.
3. They lead by thinking ahead in time, and morally creative towards new applications, extension and putting values into practice. 'Morally creative' means the identification of the most important values as applicable to the situation, bringing clarity within the groups through proper communication, and putting those values into practice.
4. They sustain professional interest, among social diversity and cross-disciplinary complexity. They contribute to the professional societies, their professions, and to their communities.

- Moral leaders are those who direct, motivate, organize, manage or in other ways take groups towards morally valuable goals
- Frederick Taylor, the father of scientific management, have pointed out that engineers and technologists were best qualified leaders to govern because of their technical expertise, logical, practical and unprejudiced minds

5.10.2. Participation in professional societies

- Moral leadership within engineering is clearly demonstrated by playing a significant role in professional bodies like IEEE, ASME, NSPE etc
- The moral leadership in engineering is manifested in leadership within the professional societies. The professional societies provide a forum for communication, and canvassing for change within and by groups.
- Engineers have to resolve the conflicts of interest, disagreement, moral dilemmas and other issues among themselves through these professional societies
- The engineers have to share the moral activity through these societies
- Engineers as moral leaders can help through these professional societies in sponsoring ethics workshops, conducting surveys on matters of concern , informing their members about recent development related to ethics and technology and encouraging educational institutions to work forward in it

5.10.3. Voluntary services

- In past engineering code of ethics have discouraged voluntarism in the engineering field. "**engineers shall not undertake nor agree to perform any engineering services on free basis"**
- Another important avenue for providing moral leadership within communities, by the engineers is to promote services without fee or at reduced fees (pro bono) to the needy groups.
- The professional societies can also promote such activities among the engineers. This type of voluntarism (or philanthropy) has been in practice in the fields of medicine, law and education.
- But many of the engineers are not self-employed as in the case of physicians and lawyers. The business institutions are encouraged to contribute a percentage of their services as free or at concessional rates for charitable purposes.

5.10.4. Community service

This is another platform for the engineers to exhibit their moral leadership. The engineers an help in guiding, organising, and stimulating the community towards morally- and

environmentally-desirable goals. The corporate organizations have come forward to adopt villages and execute many social welfare schemes, towards this objective.

The Codes of Ethics promote and sustain the ethical environment and assist in achieving the ethical goals in the following manner:

1. It creates an environment in a profession, where ethical behavior is the basic criterion.
2. It guides and reminds the person as to how to act, in any given situation.
3. It provides support to the individual, who is being pressurized or tortured by a superior or employer, to behave unethically.
4. Apart from professional societies, companies and universities have framed their own codes of ethics, based on the individual circumstances and specific mission of the organisations.

These codes of conduct help in employees' awareness of ethical issues, establish, and nurture a strong corporate ethical culture.

5.11. Corporate Social Responsibility

The term "corporate social responsibility" became popular in the 1960s and has remained a term used indiscriminately by many to cover legal and moral responsibility more narrowly construed.[10]

CSR as "A company's sense of responsibility towards the community and environment (both ecological and social) in which it operates. Companies express this citizenship (1) through their waste and pollution reduction processes, (2) by contributing educational and social programs and (3) by earning adequate returns on the employed resources."

Scope:

Initially, CSR emphasized the official behavior of individual firms. Later, it expanded to include supplier behavior and the uses to which products were put and how they were disposed of after they lost value.

Incidents like the 2013 Savar building collapse pushed companies to consider how the behavior of their suppliers impacted their overall impact on society. Irresponsible behavior reflected on both the misbehaving firm, but also on its corporate customers. Supply chain management expanded to consider the CSR context. Wieland and Handfield (2013) suggested that companies need to include social responsibility in their reviews of component quality. They highlighted the use of technology in improving visibility across the supply chain.

There are a few broad categories of social responsibility that many of today's businesses are practicing:

1. **Environmental efforts:** One primary focus of corporate social responsibility is the environment. Businesses regardless of size have a large carbon footprint. Any steps they can take to reduce those footprints are considered both good for the company and society as a whole.
2. **Philanthropy:** Businesses also practice social responsibility by donating to national and local charities. Businesses have a lot of resources that can benefit charities and local community programs.
3. **Ethical labor practices:** By treating employees fairly and ethically, companies can also demonstrate their corporate social responsibility. This is especially true of businesses that operate in international locations with labor laws that differ from those in the United States.
4. **Volunteering:** Attending volunteer events says a lot about a company's sincerity. By doing good deeds without expecting anything in return, companies are able to express their concern for specific issues and support for certain organizations.

Functions:

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CSR policy functions as a self-regulatory mechanism whereby a business monitors and ensures its active compliance with the spirit of the law, ethical standards and national or international norms. With some models, a firm's implementation of CSR goes beyond compliance and engages in "actions that appear to further some social good, beyond the interests of the firm and that which is required by law."

The binary choice between 'complying' with the law and 'going beyond' the law must be qualified with some nuance. In many areas such as environmental or labor regulations, employers can choose to comply with the law, to go beyond the law, but they can also choose to not comply with the law, such as when they deliberately ignore gender equality or the mandate to hire disabled workers.

There must be a recognition that many so-called 'hard' laws are also 'weak' laws, weak in the sense that they are poorly enforced, with no or little control and/or no or few sanctions in case of non-compliance. 'Weak' law must not be confused with Soft law .

The aim is to increase long-term profits and shareholder trust through positive public relations and high ethical standards to reduce business and legal risk by taking responsibility for corporate actions. CSR strategies encourage the company to make a positive impact on the environment and stakeholders including consumers, employees, investors, communities, and others.

Part – A

1. What is moral leadership? (May/June/2016) (Nov/Dec/2015)

- **Moral Leadership** is a very different kind of **leadership**. Rather than aspiring to being followed, Moral **Leaders** aim to serve. Instead of show casing their own skills, **Moral Leaders** tend to develop the capacities of others.
- Whenever the goals of a leader become permissible and also morally valuable, it is known as moral leadership. Moral leadership also means that employing morally acceptable ways to motivate the groups to move towards morally desirable ways. The ways are depending on thesituations.

2. What is technology transfer? (Nov/Dec/2015/2017)

Technology transfer is a process of changing the technology to a new setting and implementing it. Technology includes hardware such as machines and installations as well as techniques such as technical, organizational and managerial skills andprocedures.

3. What is meant by Globalization? (May/June/2016)

Our lives are increasingly dependent upon the goods/services produced over the world and are influenced by the business from around all the corners of the world. In general world has become a global village and have a global economy. The increasing international flow of capital, technology, trade, and people have had the effects of changing the nature of local organizations governments and people of countries and have led to social changes and developments

4. What is meant by computer ethics? (Nov/Dec/2016)

Computerscontributetoavarietyofmoralproblems.Inordertoevaluateand act appropriately with such problems, a new field of applied ethics termed as computer ethics has been developed. The study of ethical issues that are associated with computer, its peripheral and accesses series and the computing profession is called as computer ethics

5. What is code of conduct? (Nov/Dec/2016)(Apr/May/2018)

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A code of conduct is a set of rules outlining the social norms and rules and responsibilities of, or proper practices for, an individual, party or organization. Related concepts include ethical, honour, moral **codes** and religious laws.

6. Deduct the responsibilities of Consulting Engineers (Nov/Dec/2017)

Some of the responsibilities of consulting engineers are in the following areas.

- Advertising,
- Competitive bidding,
- Contingency fees,
- Safety and client needs,and
- Provisions for resolution of disputes.

7. How is corporate social responsibility practiced(May/June/2017)(Nov/Dec/2018)

There are a few broad categories of social responsibility that many of today's businesses are practicing:

- **Environmental efforts:** One primary focus of corporate social responsibility is the environment. Businesses regardless of size have a large carbon footprint. Any steps they can take to reduce those footprints are considered both good for the company and society as a whole.
- **Philanthropy:** Businesses also practice social responsibility by donating to national and local charities. Businesses have a lot of resources that can benefit charities and local community programs.
- **Ethical labor practices:** By treating employees fairly and ethically, companies can also demonstrate their corporate social responsibility. This is especially true of businesses that operate in international locations with labor laws that differ from those in the United States.
- **Volunteering:** Attending volunteer events says a lot about a company's sincerity. By doing good deeds without expecting anything in return, companies are able to express their concern for specific issues and support for certain organizations.

8. What is embezzlement?

The process of computing computer crimes such as stealing or cheating clients and conspiracy in the fraudulent uses of computer networks is called embezzlement.

9. What the hired guns?

Engineers are hired by attorneys to help them to establish the facts in away favorable to their clients. The hired guns violate the standards of honesty and also due care in conducting investigations.

10. State the most important ethical mistake made by the multinational corporation which caused Bhopal gas plant disaster.

- The tanks used to store Methyl Iso-cyanate were overloaded to a tune of75%.
- The emergency plant was also filled with a large amount ofchemicals.
- The entire refrigeration unit had been shut down as a measure to reduce the cost and this led to increase of temperatures to a higherlevel.
- One of the disappointed workers unscrewed a pressure gauge on a tank and inserted a hosepipe into it, knowing that it would cause damage, but not to this extent.
- Scrubber has also been shutdown.
- Flare tower was also not in an operatingcondition.

- Unfortunately there were no emergency drills or evacuation plantsavailable.

11. Define Conflict resolution.

Conflict resolution is the result based on some objective standard and corporate usually uses general standards for evaluating the results.

12. What is contextualize?

In accordance to Gilligan women try hard to preserve personal relationship will all people. This context-oriented emphasis on maintaining personal relationship is called as ethics of care in contrast with ethics of rules andrights.

13. What are ethical pluralism and ethical relativism?

Ethical pluralism: According to this view there may be alternative moral perspectives that are reasonable, but no one of which must be accepted completely by all rational and morally concerned persons.

Ethical relativism: Actions are morally right when they are approved by law or custom they are wrong when they violate laws orcustomers.

14. What should an ethical expert witness, even though hired by a company, expected to do?

Engineers should not become the hired-guns to their clients, but instead remain as objective as humanly possible in their investigations and the conclusions they reach .they should avoid biases resulting from money ego, and sympathy.

15. What are the international rights listed by Donaldson?

Thomas Donaldson in his book _The ethics of International Business,, has listed the following as the International rights:

- The right to freedom of physical movement
- The right to ownership of property
- The right to freedom from torture
- The right to a fair trial
- The right to nondiscriminatory treatment
- The right to physical security
- The right to freedom of speech and association
- The right to minimal education
- The right to political participation
- The right to subsistence.

16. Define appropriate technology?

Appropriate technology refers to the identification, transfer and implementation of the most suitable technology for a new set of conditions.

17. List out four examples for Multinational Corporation.

Large corporations having investment and business in number of countries are known as Multinational or Transnational corporation. Some of them are : Hindustan Lever, Ford, Toyota, Sony, LG, Smith Kline Beecham, ITC, Pondsetc.

18. What are the three senses of relative values?

Ethical Relativism

Descriptive Relativism
Moral Relativism

19. What are the demerits of Multinational Corporation to host country? (Nov/Dec/2018)

Ethical dilemmas faced by certain companies may be specific to their industry or company, other types of ethical issues are common to all types of companies. Handling ethical decisions with wisdom is especially important for small businesses, given the potentially devastating effects these companies may face if such issues aren't handled correctly.

20. What are the advantages and disadvantages of MNC's to host country? (Apr/May/2018)

Advantages of Multinational Corporations

a) Multinational corporations provide an inflow of capital.
Multinational corporations reduce government aid dependencies in the developing world
b) Multinational corporations allow countries to purchase imports
c) Multinational corporations provide local employment.
Multinational corporations improve the local infrastructure.
d) Multinational corporations diversify local economies
e) Multinational companies create consistent consumer experiences.
Multinational corporations encourage more innovation.
f) Multinational corporations enforce minimum quality standards.
g) Multinational corporations increase cultural awareness.

Disadvantages of Multinational Corporations

a) Multinational corporations don't always leave profits local.
b) Multinational corporations import skilled labor .
c) Multinational corporations create one-way raw material resource consumption
d) Multinational corporations encourage political corruption.
e) Multinational corporations support "sweatshop" labor.
f) Multinational corporations remove jobs from their home country.
g) Multinational corporations build legal monopolies.
h) Multinational corporations put other companies out of business
i) Multinational corporations create higher environmental costs

21. Differentiate the Eye witness and expert witness in the legal system (MAY/JUNE2014)

An eyewitness is one who testifies what they perceived through his or her senses (e.g. seeing, hearing, smelling, touching). That perception might be either with the unaided human sense or with the aid of an instrument, e.g., microscope or stethoscope, or by other scientific means, e.g.a chemical reagent which changes color in the presence of a particularsubstance

An expert witness is one who allegedly has specialized knowledge relevant to the matter of interest, which knowledge purportedly helps to either make sense of other evidence, including other testimony, documentary evidence or physical evidence (e.g., a fingerprint)

22. Define the term "honesty "and "moral leadership"

Honesty: A facet of moral character that connotes positive and virtuous attributes such as integrity, truthfulness, and straightforwardness, along with the absence of lying,

cheating, or theft

Moral Leadership: A process of social influence in which one person enlists the aid and support of others in accomplishing a common task.

23. What do you understand by Business ethics?

Business ethics (also corporate **ethics**) is a form of applied **ethics** or professional **ethics** that examines **ethical** principles and moral or **ethical** problems that arise in a **business** environment. It applies to all aspects of **business** conduct and is relevant to the conduct of individuals and entire organizations.

PART B

1. Describe in details about Global issues of weapons development

Or

2. Discuss the ethical role of engineers in weapon development with suitable examples **(May/June/2016/2018)(N0v/Dec/2018) Answer 5.4 – Weapons Development**

3. **Justify Engineers as expert witness and Advisors with suitable examples (May/June/2016) (Nov/Dec/2015) Answer 5.8 – Expert Witness, 5.9 – Expert Advisors**

4. **Discuss the ethical role of engineers in as a consulting Engineer with suitable examples (May/June/2017/2018) (Nov/Dec/2015)Answer 5.7 – Engineers as consultants**

5. **What is meant by Computer ethics? State and explain the categories of ethical problems and the unethical acts computer as an instrument of unethical behavior. What is meant by hacking?(Nov/Dec/2017)**

(OR)

6. **Discuss in detail about the moral and ethical issues involved in use of computers (May/June/2017) (Nov/Dec/2015/2017) Answer 5.3 – Computer Ethics**

7. **State the types of concern for environment by the engineers. Discuss the approaches to resolve environmental problems. What do professionals codes of ethics say about environment (Nov/Dec/2017) - Answer – 5.2- Environmental Ethics**

8. Explain in detail the various advantages and disadvantages of MNC's**(Nov/Dec/2016) Answer – 5.1 – Multinational corporations**

9. Explain the Bhopal gas tragedy. Discuss the violation of moral, ethical and professional codes of standards in it. write a conclusion to avoid such tragedy in future.**(APRIL/MAY/2018) Answer – 5.1.6- Bhopal Gas Tragedy**

(OR)

10. Discuss the Bhopal disaster .Explain the responsibility of engineer in the design stage itself before the event of an accident. (**MAY/JUNE 2014)(APR/MAY2015)**

PRATHYUSHA
ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

ME 6302 – MANUFACTURING TECHNOLOGY - I
LECTURE NOTES

(R- 2013)

II YEAR / III SEMESTER

Prepared by

Mr. K. ESSAKI MOORTHY AP/MECH

ME 6302 – MANUFACTURING TECHNOLOGY I L T P C 3 0 0 3

UNIT I METAL CASTING PROCESSES 9

Sand casting – Sand moulds - Type of patterns – Pattern materials – Pattern allowances – Types of

Moulding sand – Properties – Core making – Methods of Sand testing – Moulding machines – Types

of moulding machines - Melting furnaces – Working principle of Special casting processes – Shell –

investment casting – Ceramic mould – Lost Wax process – Pressure die casting – Centrifugal casting –

CO_2 process – Sand Casting defects.

UNIT II JOINING PROCESSES 9

Fusion welding processes – Types of Gas welding – Equipments used – Flame characteristics – Filler

and Flux materials - Arc welding equipments - Electrodes – Coating and specifications – Principles of

Resistance welding – Spot/butt – Seam – Projection welding – Percusion welding – GS metal arc welding – Flux cored – Submerged arc welding – Electro slag welding – TIG welding – Principle and

application of special welding processes – Plasma arc welding – Thermit welding – Electron beam

welding – Friction welding – Diffusion welding – Weld defects – Brazing – Soldering process – Methods and process capabilities – Filler materials and fluxes – Types of Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open impression and closed die forging – Characteristics of the process – Types of Forging Machines – Typical forging operations –

Rolling of metals – Types of Rolling mills – Flat strip rolling – Shape rolling operations – Defects in

rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types of

Extrusion – Hot and Cold extrusion – Equipments used.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing operations – Bending – Drawing operations – Stretch forming operations — Formability of sheet metal – Test methods – Working principle and application of special forming processes – Hydro forming – Rubber pad forming – Metal spinning – Introduction to Explosive forming – Magnetic pulse forming – Peen forming – Super plastic forming.

UNIT V MANUFACTURING OF PLASTIC COMPONENTS 9

Types of plastics – Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of – Injection moulding – Plunger and screw machines – Compression moulding – Transfer moulding – Typical industrial applications –Introduction to Blow moulding – Rotational moulding – Film blowing – Extrusion – Thermoforming –Bonding of Thermoplastics.

Total: 45

TEXT BOOKS

1. Hajra Choudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promotors Pvt Ltd., 2001

2. S.Gowri, P.Hariharan, and A.Suresh Babu, “Manufacturing Technology I”, Pearson Education,2008.

REFERENCES

1. B.S. Magendran Parashar & R.K. Mittal, “Elements of Manufacturing Processes”, Prentice Hall of India, 2003.

2. P.N. Rao, “Manufacturing Technology”, 2nd Edition, Tata McGraw-Hill Publishing Limited, 2002.

3. P.C. Sharma, “A Text Book of Production Technology”, 4th Edition, S. Chand and Company, 2003.

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UNIT I
Metal Casting Process

Manufacturing

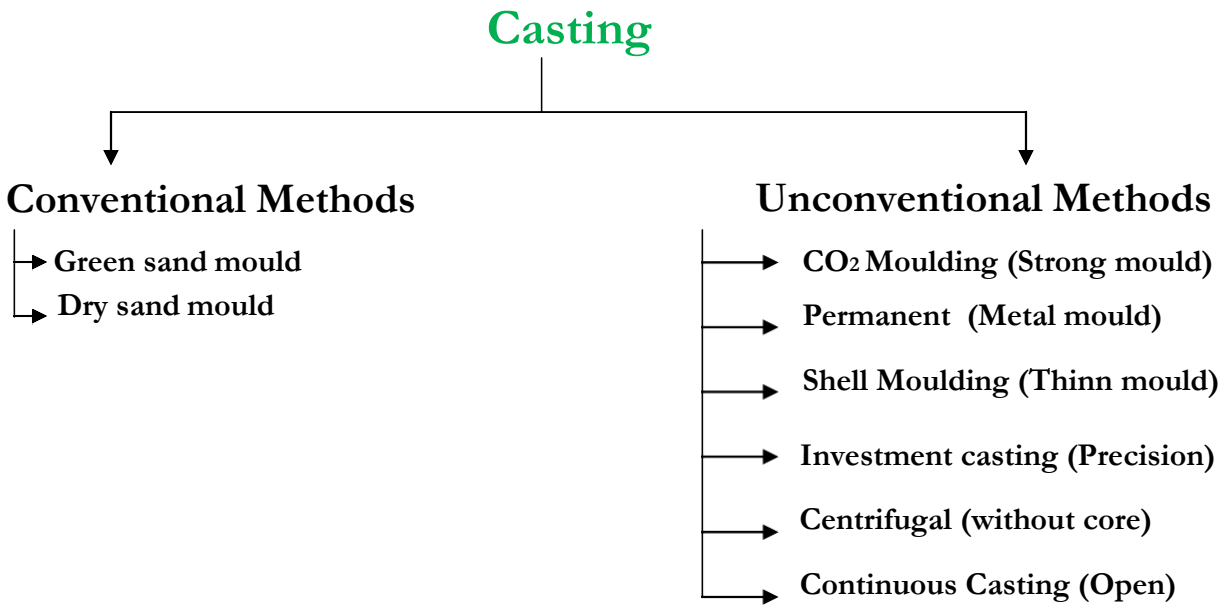
- Manufacturing in its broadest sense is the process of converting raw materials into useful products.
- It includes

i) Design of the product
ii) Selection of raw materials and
iii) The sequence of processes through which the product will be manufactured.

Casting

Casting is the process of producing metal parts by pouring molten metal into the mould cavity of the required shape and allowing the metal to solidify. The solidified metal piece is called as "casting".

Types of casting



Advantages

- Design flexibility
- Reduced costs
- Dimensional accuracy
- Versatility in production

Disadvantages

- Lot of molten metal is wasted in riser & gating
- Casting may require machining to remove rough surfaces

Sand Casting

Sand Casting is simply melting the metal and pouring it into a preformed cavity, called mold, allowing (the metal to solidify and then breaking up the mold to remove casting. In sand casting expandable molds are used. So for each casting operation you have to form a new mold.

• Most widely used casting process.
• Parts ranging in size from small to very large
• Production quantities from one to millions
• Sand mold is used.
• Patterns and Cores
  – Solid, Split, Match-plate and Cope-and-drag Patterns
  – Cores – achieve the internal surface of the part

Molds

- Sand with a mixture of water and bonding clay
- Typical mix: 90% sand, 3% water, and 7% clay
- to enhance strength and/or permeability

Sand – Refractory for high temperature

Size and shape of sand

Small grain size -> better surface finish
Large grain size -> to allow escape of gases during pouring
Irregular grain shapes -> strengthen molds due to interlocking but to reduce permeability

Types of sand

a) Green-sand molds - mixture of sand, clay, and water; “Green" means mold contains moisture at time of pouring.
b) Dry-sand mold - organic binders rather than clay and mold is baked to improve strength
c) Skin-dried mold - drying mold cavity surface of a green-sand

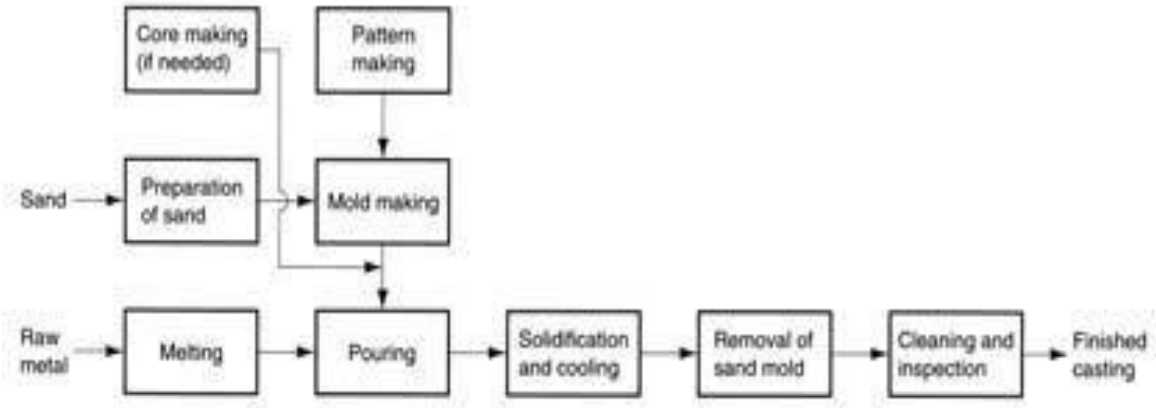
- mold to a depth of 10 to 25 mm, using torches or heating

Steps in Sand Casting

The cavity in the sand mold is formed by packing sand around a pattern, separating the mold into two halves

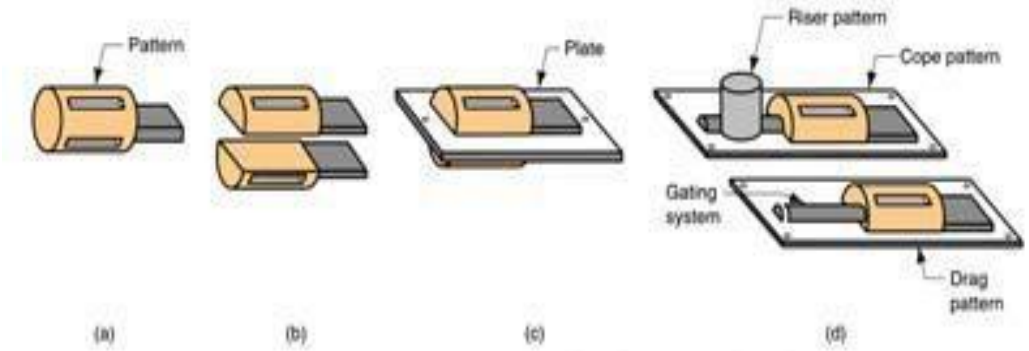
- The mold must also contain gating and riser system
- For internal cavity, a core must be included in mold
- A new sand mold must be made for each part

1. Pour molten metal into sand mold
2. Allow metal to solidify
3. Break up the mold to remove casting
4. Clean and inspect casting
5. Heat treatment of casting is sometimes required to improve metallurgical properties



Types of patterns used in sand casting

(a) solid pattern
(b) split pattern
(c) match-plate pattern
(d) cope and drag pattern



Pattern Allowances

Five types of allowances were taken into consideration for various reasons. They are described as follows:

1. Shrinkage allowance
2. Draft allowance
3. Finish allowance
4. Shake allowance
5. Distortion allowance

Desirable Mold Properties and Characteristics

- Strength - to maintain shape and resist erosion
- Permeability - to allow hot air and gases to pass through voids in sand
- Thermal stability - to resist cracking on contact with molten metal
- Collapsibility - ability to give way and allow casting to shrink without cracking the casting
- Reusability - can sand from broken mold be reused to make other molds.

Testing of Mould & Core sand

1) Preparation of standard test specimen
2) Mould hardness test
3) Core hardness test
4) Moisture content test on foundry sand
5) Sieve analysis
6) Clay content test
7) Permeability test
8) Compression, shear test

Other Expendable Mold Casting

- Shell Molding
- Vacuum Molding
- Expanded Polystyrene Process
- Investment casting
- Plaster and Ceramic Mold casting

Steps in shell-molding

Shell-mold casting yields better surface quality and tolerances. The process is described as follows:

The 2-piece pattern is made of metal (e.g. aluminum or steel), it is heated to between 175°C- 370°C, and coated with a lubricant, e.g. silicone spray.

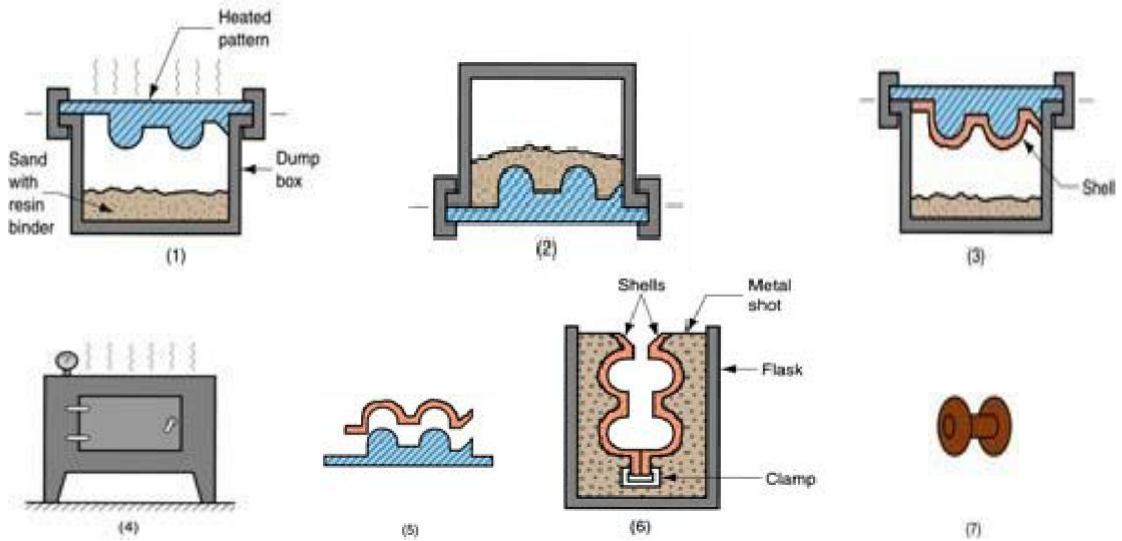
Each heated half-pattern is covered with a mixture of sand and a thermoset resin/epoxy binder.

The binder glues a layer of sand to the pattern, forming a shell. The process may be repeated to get a thicker shell.

The assembly is baked to cure it.

The patterns are removed, and the two half-shells joined together to form the mold; metal is poured into the mold.

When the metal solidifies, the shell is broken to get the part.



Advantages

- Smoother cavity surface permits easier flow of molten metal and better surface finish on casting
- Good dimensional accuracy
- Machining often not required
- Mold collapsibility usually avoids cracks in casting
- Can be mechanized for mass production

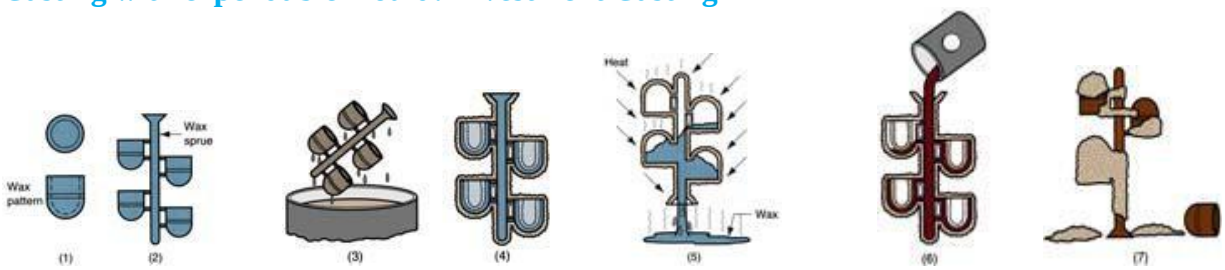
Disadvantages

- More expensive metal pattern
- Difficult to justify for small quantities

Investment Casting

- Investment casting produces very high surface quality and dimensional accuracy.
- Investment casting is commonly used for precision equipment such as surgical equipment, for complex geometries and for precious metals.
- This process is commonly used by artisans to produce highly detailed artwork.
- The first step is to produce a pattern or replica of the finished mould. Wax is most commonly used to form the pattern, although plastic is also used.
- Patterns are typically mass-produced by injecting liquid or semi-liquid wax into a permanent die.
- Prototypes, small production runs and specialty projects can also be undertaken by carving wax models.
- Cores are typically unnecessary but can be used for complex internal structures. Rapid prototyping techniques have been developed to produce expendable patterns.
- Several replicas are often attached to a gating system constructed of the same material to form a tree assembly. In this way multiple castings can be produced in a single pouring.

Casting with expendable mould: Investment Casting



Advantages

– Parts of great complexity and intricacy can be cast
– Close dimensional control and good surface finish
– Wax can usually be recovered for reuse
– Additional machining is not normally required - this is a net shape process

Disadvantages

– Many processing steps are required
– Relatively expensive process

Plaster Molding

• Similar to sand casting except mold is made of plaster of Paris (gypsum - CaSO4-2H2O)
• Plaster and water mixture is poured over plastic or metal pattern to make a mold

Advantages

– Good dimensional accuracy and surface finish
– Capability to make thin cross-sections in casting

Disadvantages

- Moisture in plaster mold causes problems:
- Mold must be baked to remove moisture
- Mold strength is lost when is over-baked, yet moisture content can cause defects in product
- Plaster molds cannot stand high temperatures

Permanent Mold Casting

Basic Permanent Mold Process
– Uses a metal mold constructed of two sections designed for easy, precise opening and closing
– Molds for lower melting point alloys: steel or cast iron and Molds for steel: refractory material, due to the very high pouring temperatures

Permanent Mold Casting Process

- The two halves of the mold are made of metal, usually cast iron, steel, or refractory alloys. The cavity, including the runners and gating system are machined into the mold halves.
- For hollow parts, either permanent cores (made of metal) or sand-bonded ones may be used, depending on whether the core can be extracted from the part without damage after casting.
- The surface of the mold is coated with clay or other hard refractory material – this improves the life of the mold. Before molding, the surface is covered with a spray of graphite or silica, which acts as a lubricant. This has two purposes – it improves the flow of the liquid metal, and it allows the cast part to be withdrawn from the mold more easily.
- The process can be automated, and therefore yields high throughput rates.
- It produces very good tolerance and surface finish.
- It is commonly used for producing pistons used in car engines; gear blanks, cylinder heads, and other parts made of low melting point metals, e.g. copper, bronze, aluminum, magnesium, etc.

Advantage

- Good surface finish and dimensional control and Fine grain due to rapid solidification.

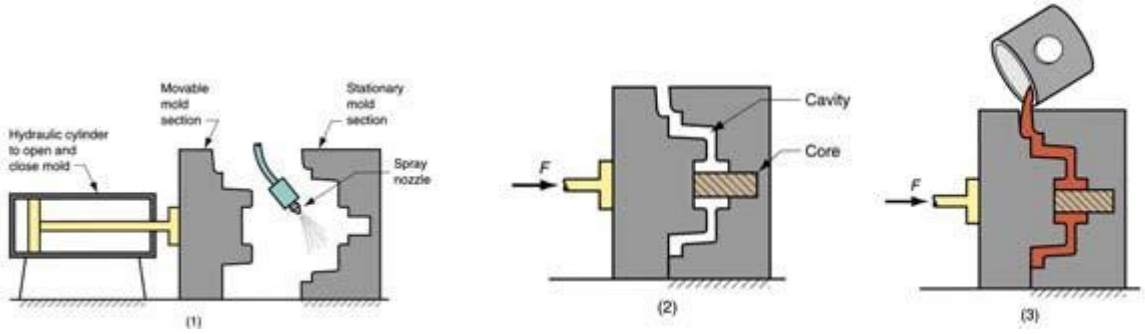
Disadvantage

- Simple geometric part, expensive mold.

Example

It is commonly used for producing pistons used in car engines; gear blanks, cylinder heads, and other parts made of low melting point metals, e.g. copper, bronze, aluminum, magnesium, etc.

1Basic Permanent Mold Process



Advantages

– Good dimensional control and surface finish
– More rapid solidification caused by the cold metal mold results in a finer grain structure, so stronger castings are produced

Limitations

- Generally limited to metals of lower melting point
- Simple part geometries compared to sand casting because of the need to open the mold
- High cost of mold
- Due to high mold cost, process is best suited to automated high volume production

Testing of Mould & Core sand

1) Preparation of standard test specimen
2) Mould hardness test
3) Core hardness test
4) Moisture content test on foundry sand
5) Sieve analysis
6) Clay content test
7) Permeability test
8) Compression, shear test

Die Casting

• Die casting is a very commonly used type of permanent mold casting process.
• It is used for producing many components of home appliances (e.g rice cookers, stoves, fans, washing and drying machines, fridges), motors, toys and hand-tools
• The molten metal is injected into mold cavity (die) under high pressure (7-350MPa). Pressure maintained during solidification.
• Hot Chamber (Pressure of 7 to 35MPa)
• The injection system is submerged under the molten metals (low melting point metals such as lead, zinc, tin and magnesium)
• Cold Chamber (Pressure of 14 to 140MPa)
• External melting container (in addition aluminum, brass and magnesium)
Molds are made of tool steel, mold steel, maraging steel, tungsten and molybdenum.
• Single or multiple cavity
• Lubricants and Ejector pins to free the parts

• Venting holes and passageways in die
• Formation of flash that needs to be trimmed

Properties of die-casting

1) Huge numbers of small, light castings can be produced with great accuracy.
2) Little surface finishing is required.
3) Permanent mold (dies can be used over and over)

Advantages

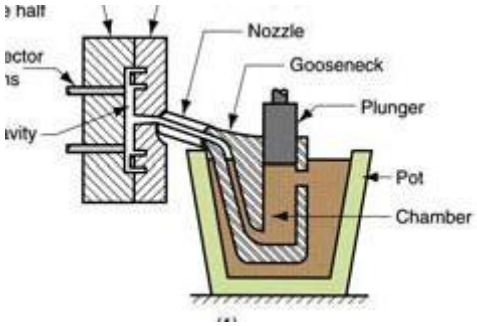
– High production, Economical, close tolerance, good surface finish, thin sections, rapid cooling

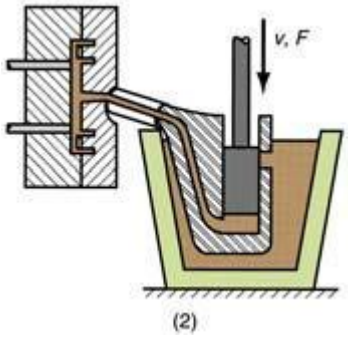
Hot-Chamber Die Casting

In a hot chamber process (used for Zinc alloys, magnesium) the pressure chamber connected to the die cavity is filled permanently in the molten metal.
The basic cycle of operation is as follows:

(i) die is closed and gooseneck cylinder is filled with molten metal;
(ii) plunger pushes molten metal through gooseneck passage and nozzle and into the die cavity; metal is held under pressure until it solidifies;
(iii) die opens and cores, if any, are retracted; casting stays in ejector die; plunger returns, pulling molten metal back through nozzle and gooseneck;
(iv) ejector pins push casting out of ejector die. As plunger uncovers inlet hole, molten metal refills gooseneck cylinder.

The hot chamber process is used for metals that (a) have low melting points and (b) do not alloy with the die material, steel; common examples are tin, zinc, and lead.



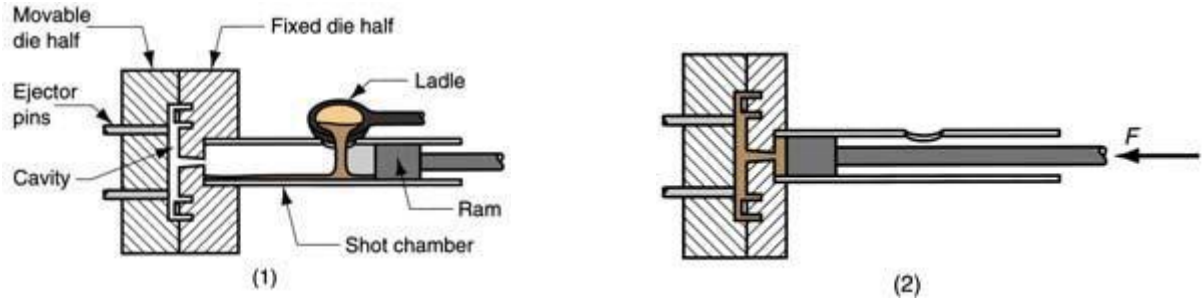


Cold Chamber Die Casting

In a cold chamber process, the molten metal is poured into the cold chamber in each cycle. The operating cycle is

(i) Die is closed and molten metal is ladled into the cold chamber cylinder;
(ii) plunger pushes molten metal into die cavity; the metal is held under high pressure until it solidifies;
(iii) die opens and plunger follows to push the solidified slug from the cylinder, if there are cores, they are retracted away;
(iv) ejector pins push casting off ejector die and plunger returns to original position

This process is particularly useful for high melting point metals such as Aluminum, and Copper (and its alloys).



Advantages

– Economical for large production quantities
– Good dimensional accuracy and surface finish
– Thin sections are possible
– Rapid cooling provides small grain size and good strength to casting

Disadvantages

– Generally limited to metals with low metal points
– Part geometry must allow removal from die cavity

Centrifugal casting

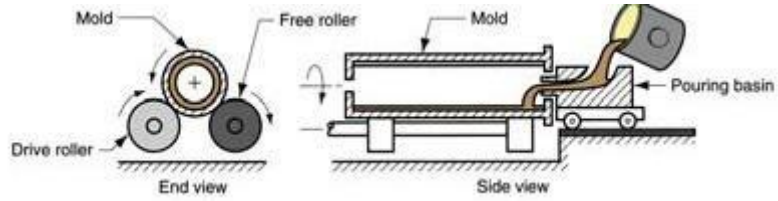
Centrifugal casting uses a permanent mold that is rotated about its axis at a speed between 300 to 3000 rpm as the molten metal is poured.

Centrifugal forces cause the metal to be pushed out towards the mold walls, where it solidifies after cooling.

Centrifugal casting has greater reliability than static castings. They are relatively free from gas and shrinkage porosity.

Surface treatments such as case carburizing, flame hardening and have to be used when a wear resistant surface must be combined with a hard tough exterior surface.

One such application is bimetallic pipe consisting of two separate concentric layers of different alloys/metals bonded together.



Carbon Dioxide Moulding

- This sand is mixed with 3 to 5 % sodium silicate liquid base binder in muller for 3 to 4 minutes. Additives such as coal powder, wood flour sea coal, dextrine may be added to improve its properties.
- Aluminium oxide Kaolin clay may also added to the sand .

- Patterns used in this method may be coated with Zinc of 0.05 mm to 0.13 mm and then spraying a layer of aluminium or brass of about 0.25 mm thickness for good surface finish and good results.

Advantages

- Operation is speedy since we can use the mould and cores immediately after processing.
- Heavy and rush orders
- Floor space requirement is less
- Semi skilled labour may be used.

Disadvantages

Difficult in reusing the moulding sand.

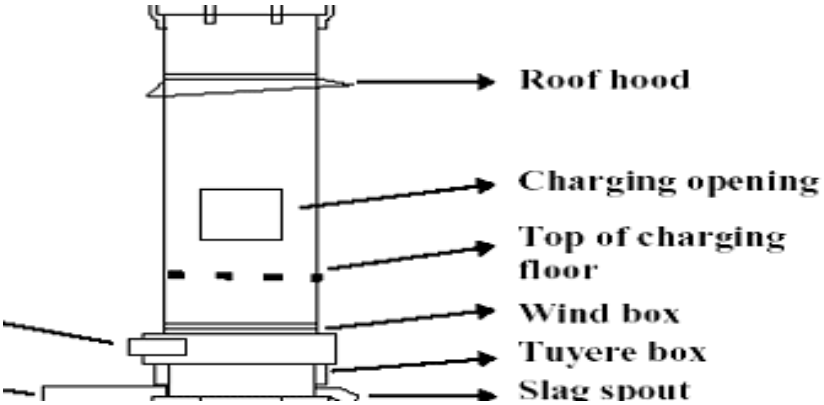
Process	Advantages	Disadvantages	Examples
Sand	Wide range of metals, sizes, shapes, low cost	poor finish, wide tolerance	engine blocks, cylinder heads
Shell mold	better accuracy, finish, higher production rate	limited part size	connecting rods, gear housings
Expendable pattern	Wide range of metals, sizes, shapes	patterns have low strength	cylinder heads, brake components
Plaster mold	complex shapes, good surface finish	non-ferrous metals, low production rate	prototypes of mechanical parts
Ceramic mold	complex shapes, high accuracy, good finish	small sizes	impellers, injection mold tooling
Investment	complex shapes, excellent finish	small parts, expensive	jewellery
Permanent mold	good finish, low porosity, high production rate	Costly mold, simpler shapes only	gears, gear housings
Die	Excellent dimensional accuracy, high production rate	costly dies, small parts, non-ferrous metals	precision gears, camera bodies, car wheels
Centrifugal	Large cylindrical parts, good quality	Expensive, limited shapes	pipes, boilers, flywheels

Furnaces

Cupola Furnace

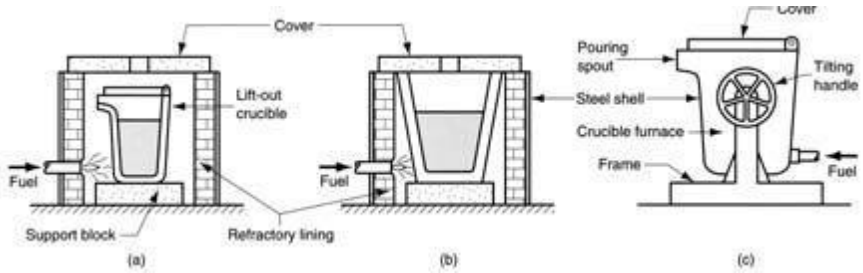
- A continuous flow of iron emerges from the bottom of the furnace.
- Depending on the size of the furnace, the flow rate can be as high as 100 tonnes per hour.

At the metal melts it is refined to some extent, which removes contaminants. This makes this process more suitable than electric furnaces for dirty charges.

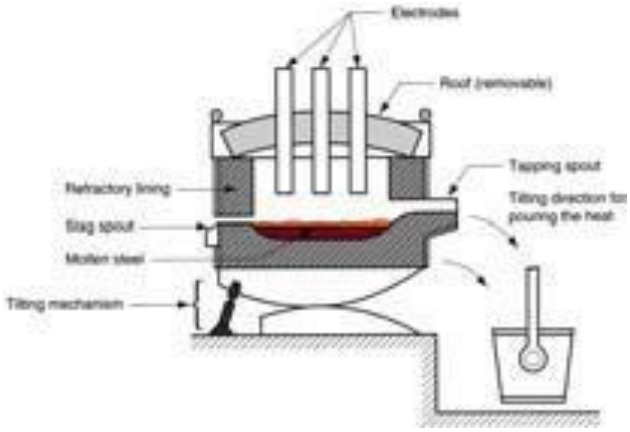


Direct Fuel-fired furnace

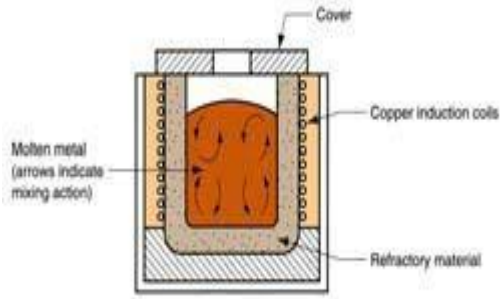
–Crucible Furnace
– Electric-arc Furnace
– Induction Furnace
• Pouring with ladle
• Solidification – watch for oxidation
• Trimming, surface cleaning, repair and heat treat, inspection



Three types: (a) lift-out crucible, (b) stationary pot, from which molten metal must be ladled, and (c) tilting-pot furnace



Induction Furnace:



Casting defects

Defects may occur due to one or more of the following reasons:

- Fault in design of casting pattern
- Fault in design on mold and core
- Fault in design of gating system and riser
- Improper choice of moulding sand
- Improper metal composition
- Inadequate melting temperature and rate of pouring

Some common defects in castings:

a) Misruns b) Cold Shut c) Cold Shot d) Shrinkage Cavity e) Microporosity f) Hot Tearing
Misruns:

a)Misruns

It is a casting that has solidified before completely filling the mold cavity.
Typical causes include
1) Fluidity of the molten metal is insufficient,
2) Pouring Temperature is too low,
3) Pouring is done too slowly and/or
4) Cross section of the mold cavity is too thin.

b) Cold Shut

A cold shut occurs when two portion of the metal flow together, but there is lack of fusion between them due to premature freezing, Its causes are similar to those of a Misruns.

c) Cold Shots

When splattering occurs during pouring, solid globules of the metal are formed that become entrapped in the casting. Poring procedures and gating system designs that avoid splattering can prevent these defects.

d) Shrinkage Cavity

This defects is a depression in the surface or an internal void in the casting caused by solidification shrinkage that restricts the amount of the molten metal available in the last region to freeze.

e) Microporosity

This refers to a network of a small voids distributed throughout the casting caused by localized solidification shrinkage of the final molten metal in the dendritic structure.

f) Hot Tearing

This defect, also called hot cracking, occurs when the casting is restrained or early stages of cooling after solidification.

Unit II JOINING PROCESSES

Welding

Welding is a materials joining process which produces coalescence of materials by heating them to suitable temperatures with or without the application of pressure or by the application of pressure alone, and with or without the use of filler material.

Welding is used for making permanent joints.

It is used in the manufacture of automobile bodies, aircraft frames, railway wagons, machine frames, structural works, tanks, furniture, boilers, general repair work and ship building.

Classification of welding processes

(i) Arc welding

- Carbon arc
- Metal arc
- Metal inert gas
- Tungsten inert gas
- Plasma arc
- Submerged arc
- Electro-slag

(ii) Gas Welding

- Oxy-acetylene
- Air-acetylene
- Oxy-hydrogen

iii) Resistance Welding

- Butt
- Spot
- Seam
- Projection
- Percussion

(iv)Thermit Welding

(v)Solid State Welding

Friction
Ultrasonic
Diffusion
Explosive

(vi) Newer Welding

Electron-beam
Laser

(vii)Related Process

Oxy-acetylene cutting
Arc cutting
Hard facing
Brazing
Soldering

Welding practice & equipment

STEPS :

- Prepare the edges to be joined and maintain the proper position
- Open the acetylene valve and ignite the gas at tip of the torch
- Hold the torch at about 45deg to the work piece plane
- Inner flame near the work piece and filler rod at about 30 – 40 deg
- Touch filler rod at the joint and control the movement according to the flow of the material

Two Basic Types of AW Electrodes

- Consumable – consumed during welding process
  - Source of filler metal in arc welding
- Nonconsumable – not consumed during welding process
  - Filler metal must be added separately

Consumable Electrodes

Forms of consumable electrodes

- Welding rods (a.k.a. sticks) are 9 to 18 inches and 3/8 inch or less in diameter and must be changed frequently
- Weld wire can be continuously fed from spools with long lengths of wire, avoiding frequent interruptions

In both rod and wire forms, electrode is consumed by arc and added to weld joint as filler metal.

Nonconsumable Electrodes

- Made of tungsten which resists melting
- Gradually depleted during welding (vaporization is principal mechanism)
- Any filler metal must be supplied by a separate wire fed into weld pool

Flux

A substance that prevents formation of oxides and other contaminants in welding, or dissolves them and facilitates removal

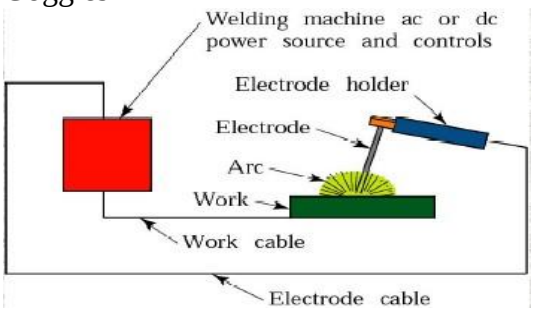
- Provides protective atmosphere for welding
- Stabilizes arc
- Reduces spattering

Arc welding

Uses an electric arc to coalesce metals
Arc welding is the most common method of welding metals
Electricity travels from electrode to base metal to ground

Arc welding Equipments

- A welding generator (D.C.) or Transformer (A.C.)
- Two cables- one for work and one for electrode
- Electrode holder
- Electrode
- Protective shield
- Gloves
- Wire brush
- Chipping hammer
- Goggles



Advantages

- Most efficient way to join metals
- Lowest-cost joining method
- Affords lighter weight through better utilization of materials
- Joins all commercial metals
- Provides design flexibility

Disadvantages

- Manually applied, therefore high labor cost.
- Need high energy causing danger
- Not convenient for disassembly.
- Defects are hard to detect at joints.

GAS WELDING

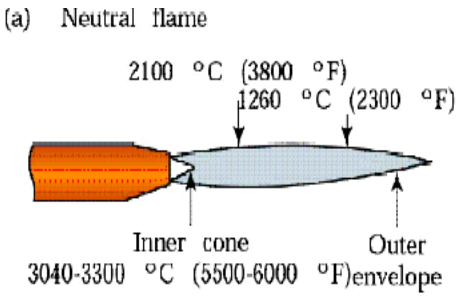
- Sound weld is obtained by selecting proper size of flame, filler material and method of moving torch
- The temperature generated during the process is 33000c.
- When the metal is fused, oxygen from the atmosphere and the torch combines with molten metal and forms oxides, results defective weld
- Fluxes are added to the welded metal to remove oxides
- Common fluxes used are made of sodium, potassium. Lithium and borax.
- Flux can be applied as paste, powder, liquid. solid coating or gas.

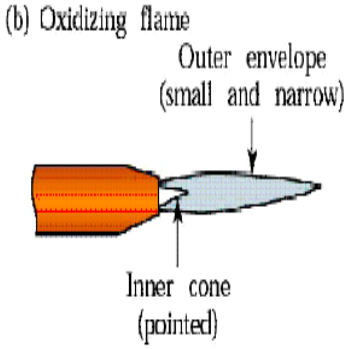
GAS WELDING EQUIPMENT

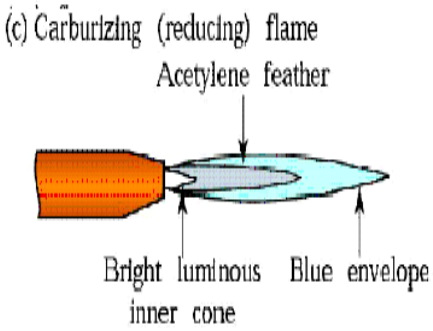
1.Gas Cylinders
Pressure
Oxygen – 125 kg/cm2
Acetylene – 16 kg/cm2
2. Regulators
Working pressure of oxygen 1 kg/cm2
Working pressure of acetylene 0.15 kg/cm2
Working pressure varies depends upon the thickness of the work pieces welded.
3. Pressure Gauges
4. Hoses
5. Welding torch
6. Check valve
7. Non return valve

Types of Flames

- Oxygen is turned on, flame immediately changes into a long white inner area (Feather) surrounded by a transparent blue envelope is called **Carburizing flame** (30000c)
- Addition of little more oxygen give a bright whitish cone surrounded by the transparent blue envelope is called **Neutral flame** (It has a balance of fuel gas and oxygen) (32000c)
- Used for welding steels, aluminium, copper and cast iron
- If more oxygen is added, the cone becomes darker and more pointed, while the envelope becomes shorter and more fierce is called **Oxidizing flame**
- Has the highest temperature about 34000c
- Used for welding brass and brazing operation







Three basic types of oxyacetylene flames used in oxyfuel-gas welding and cutting operations:

(a) neutral flame; (b) oxidizing flame; (c) carburizing, or reducing flame.

Fusion welding processes

- Definition : Fusion Welding is defined as melting together and coalescing materials by means of heat
- Energy is supplied by thermal or electrical means
- Fusion welds made without filler metals are known as autogenous welds

Filler Metals:

- Additional material to weld the weld zone
- Available as rod or wire
- They can be used bare or coated with flux
- The purpose of the flux is to retard the

Shielded metal arc welding process

- An electric arc is generated between a coated electrode and the parent metal
- The coated electrode carries the electric current to form the arc, produces a gas to control the atmosphere and provides filler metal for the weld bead
- Electric current may be AC or DC. If the current is DC, the polarity will affect the weld size and application

Process

- Intense heat at the arc melts the tip of the electrode
- Tiny drops of metal enter the arc stream and are deposited on the parent metal
- As molten metal is deposited, a slag forms over the bead which serves as an insulation against air contaminants during cooling
- After a weld „pass" is allowed the cool, the oxide layer is removed by a chipping hammer and then cleaned with a wirebrush before the next pass.

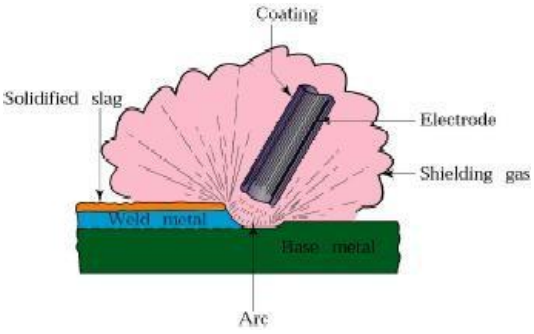


Fig : Schematic illustration of the shielded metal-arc welding process. About 50% of all large-scale industrial welding operations use this process.

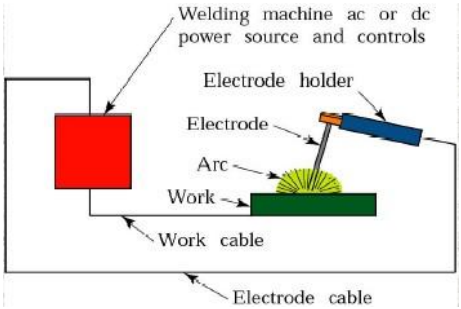


Fig : Schematic illustration of the shielded metal-arc welding process (also known as stick welding, because the electrode is in the shape of a stick).

Submerged arc welding

- Weld arc is shielded by a granular flux , consisting of silica, lime, manganese oxide, calcium fluoride and other compounds.
- Flux is fed into the weld zone by gravity flow through nozzle

- Thick layer of flux covers molten metal

- Flux acts as a thermal insulator ,promoting deep penetration of heat into the work piece
- Consumable electrode is a coil of bare round wire fed automatically through a tube
- Power is supplied by 3-phase or 2-phase power lines

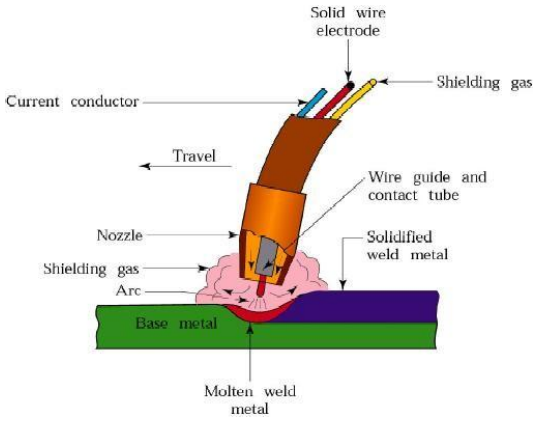


Fig : Schematic illustration of the submerged-arc welding process and equipment. The unfused flux is recovered and reused.

Gas metal arc welding

- GMAW is a metal inert gas welding (MIG)
- Weld area shielded by an effectively inert atmosphere of argon,helium,carbon dioxide,various other gas mixtures
- Metal can be transferred by 3 methods :
- Spray transfer
- Globular transfer
- Short circuiting

Process capabilities

- GMAV process is suitable for welding a variety of ferrous and non-ferrous metals
- Process is versatile ,rapid, economical, welding productivity is double that of SMAW

Flux cored arc welding

- Flux cored arc welding is similar to a gas metal arc welding
- Electrode is tubular in shape and is filled with flux
- Cored electrodes produce more stable arc improve weld contour and produce better mechanical properties
- Flux is more flexible than others

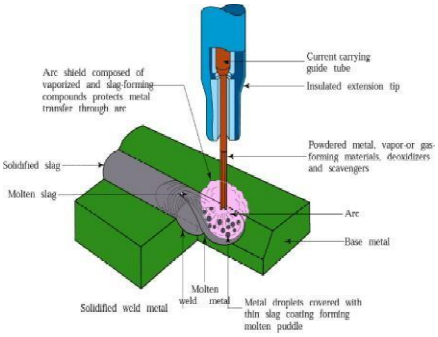


Fig : Schematic illustration of the flux-cored arc-welding process. This operation is similar to gas metal-arc welding.

Electro gas Welding

- EGW is welding the edges of sections vertically in one pass with the pieces placed edge to edge
- Similar to Electro gas welding
- Weld metal is deposited into weld cavity between the two pieces to be joined
- Difference is Arc is started between electrode tip and bottom part of the part to be welded
- Flux added first and then melted by the heat on the arc
- Molten slag reaches the tip of the electrode and the arc is extinguished
- Heat is then continuously produced by electrical resistance of the molten slag
- Single or multiple solid as well as flux-cored electrodes may be used

Process capabilities

- Weld thickness ranges from 12mm to 75mm
- Metals welded are steels, titanium, aluminum alloys
- Applications are construction of bridges, pressure vessels, thick walled and large diameter pipes, storage tanks and ships.

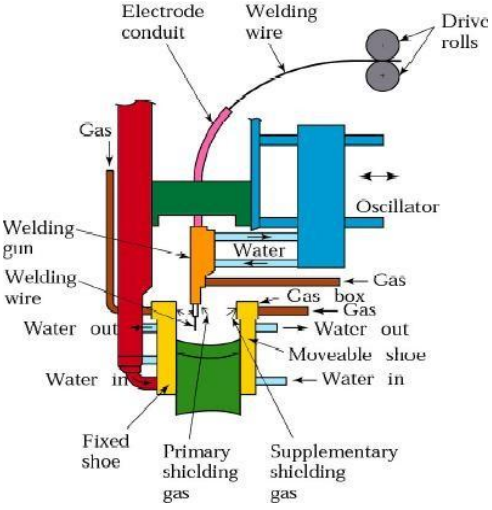


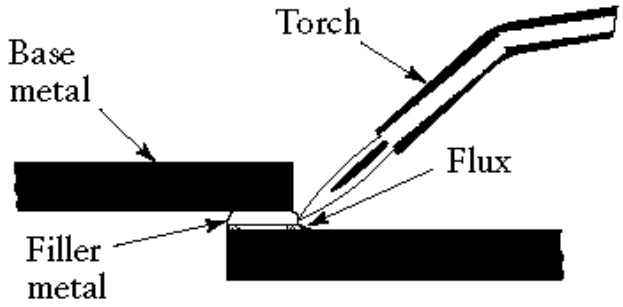
Fig : Schematic illustration of the electrogas welding process

Brazing

It is a low temperature joining process. It is performed at temperatures above 840º F and it generally affords strengths comparable to those of the metal which it joins. It is low temperature in that it is done below the melting point of the base metal. It is achieved by diffusion without fusion (melting) of the base

Brazing can be classified as

Torch brazing
Dip brazing
Furnace brazing
Induction brazing



Advantages

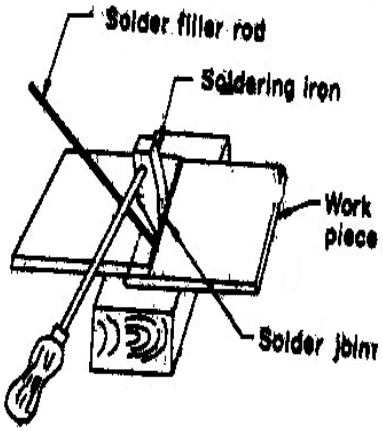
- Dissimilar metals which canot be welded can be joined by brazing
- Very thin metals can be joined
- Metals with different thickness can be joined easily
- In brazing thermal stresses are not produced in the work piece. Hence there is no distortion
- Using this process, carbides tips are brazed on the steel tool holders

Disadvantages

- Brazed joints have lesser strength compared to welding
- Joint preparation cost is more
- Can be used for thin sheet metal sections

Soldering

- It is a low temperature joining process. It is performed at temperatures below 840ºF for joining.
- Soldering is used for,
    - Sealing, as in automotive radiators or tin cans
    - Electrical Connections
    - Joining thermally sensitive components
    - Joining dissimilar metals



Inert Gas Welding

For materials such as Al or Ti which quickly form oxide layers, a method to place an inert atmosphere around the weld puddle had to be developed

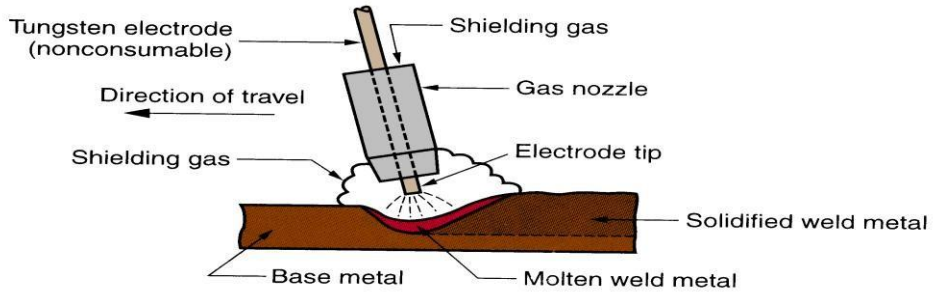
Metal Inert Gas (MIG)

- Uses a consumable electrode (filler wire made of the base metal)
- Inert gas is typically Argon

Gas Tungsten Arc Welding (GTAW)

Uses a non-consumable tungsten electrode and an inert gas for arc shielding

- Melting point of tungsten = 3410°C (6170°F)
- A.k.a. Tungsten Inert Gas (TIG) welding
  - In Europe, called "WIG welding"
- Used with or without a filler metal
  - When filler metal used, it is added to weld pool from separate rod or wire
- Applications: aluminum and stainless steel most common



Advantages

- High quality welds for suitable applications
- No spatter because no filler metal through arc
- Little or no post-weld cleaning because no flux

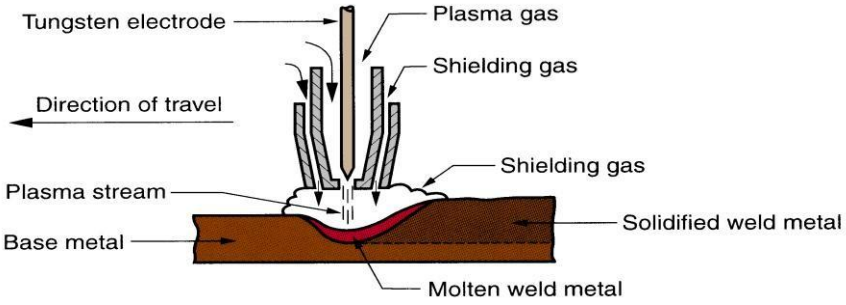
Disadvantages

- Generally slower and more costly than consumable electrode AW processes

Plasma Arc Welding (PAW)

Special form of GTAW in which a constricted plasma arc is directed at weld area

- Tungsten electrode is contained in a nozzle that focuses a high velocity stream of inert gas (argon) into arc region to form a high velocity, intensely hot plasma arc stream
- Temperatures in PAW reach 28,000℃ (50,000 ℉), due to constriction of arc, producing a plasma jet of small diameter and very high energy density



Resistance Welding (RW)

A group of fusion welding processes that use a combination of heat and pressure to accomplish coalescence

- Heat generated by electrical resistance to current flow at junction to be welded
- Principal RW process is resistance spot welding (RSW)

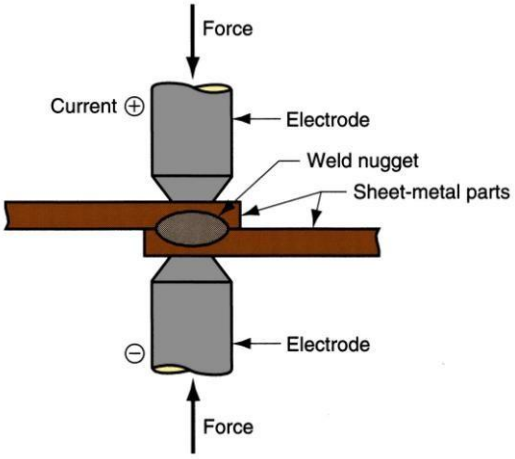


Fig: Resistance welding, showing the components in spot welding, the main process in the RW group.

Components in Resistance Spot Welding

- Parts to be welded (usually sheet metal)
- Two opposing electrodes
- Means of applying pressure to squeeze parts between electrodes
- Power supply from which a controlled current can be applied for a specified time duration

Advantages

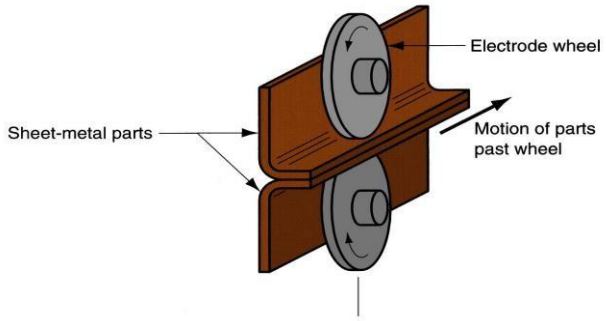
- No filler metal required

- High production rates possible
- Lends itself to mechanization and automation
- Lower operator skill level than for arc welding
- Good repeatability and reliability

Disadvantages

- High initial equipment cost
- Limited to lap joints for most RW processes

Resistance Seam Welding



Electron Beam Welding (EBW)

Fusion welding process in which heat for welding is provided by a highly-focused, high-intensity stream of electrons striking work surface

- Electron beam gun operates at:
  - High voltage (e.g., 10 to 150 kV typical) to accelerate electrons
  - Beam currents are low (measured in milliamps)
- Power in EBW not exceptional, but power density is

Advantages

- High-quality welds, deep and narrow profiles
- Limited heat affected zone, low thermal distortion
- High welding speeds
- No flux or shielding gases needed

Disadvantages

- High equipment cost
- Precise joint preparation & alignment required
- Vacuum chamber required
- Safety concern: EBW generates x-rays

Laser Beam Welding (LBW)

Fusion welding process in which coalescence is achieved by energy of a highly concentrated, coherent light beam focused on joint

- Laser = "light amplification by stimulated emission of radiation"
- LBW normally performed with shielding gases to prevent oxidation

- Filler metal not usually added
- High power density in small area, so LBW often used for small parts

Comparison: LBW vs. EBW

- No vacuum chamber required for LBW
- No x-rays emitted in LBW
- Laser beams can be focused and directed by optical lenses and mirrors
- LBW not capable of the deep welds and high depth-to-width ratios of EBW
    - Maximum LBW depth = ~ 19 mm (3/4 in), whereas EBW depths = 50 mm (2 in)

Thermit Welding (TW)

FW process in which heat for coalescence is produced by superheated molten metal from the chemical reaction of thermite

- Thermite = mixture of Al and Fe3O4 fine powders that produce an exothermic reaction when ignited
- Also used for incendiary bombs
- Filler metal obtained from liquid metal
- Process used for joining, but has more in common with casting than welding

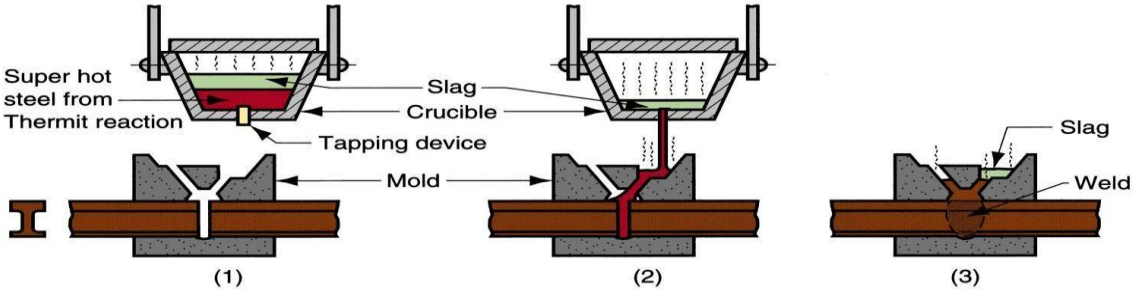


Fig: Thermit welding: (1) Thermit ignited; (2) crucible tapped, superheated metal flows into mold; (3) metal solidifies to produce weld joint.

Applications

- Joining of railroad rails
- Repair of cracks in large steel castings and forgings
- Weld surface is often smooth enough that no finishing is required

Diffusion Welding (DFW)

SSW process uses heat and pressure, usually in a controlled atmosphere, with sufficient time for diffusion and coalescence to occur

- Temperatures ≤ 0.5 Tm
- Plastic deformation at surfaces is minimal
- Primary coalescence mechanism is solid state diffusion
- Limitation: time required for diffusion can range from seconds to hours

Applications

- Joining of high-strength and refractory metals in aerospace and nuclear industries
- Can be used to join either similar and dissimilar metals
- For joining dissimilar metals, a filler layer of different metal is often sandwiched between base metals to promote diffusion

Friction Welding (FRW)

SSW process in which coalescence is achieved by frictional heat combined with pressure

- When properly carried out, no melting occurs at faying surfaces
- No filler metal, flux, or shielding gases normally used
- Process yields a narrow HAZ
- Can be used to join dissimilar metals
- Widely used commercial process, amenable to automation and mass production

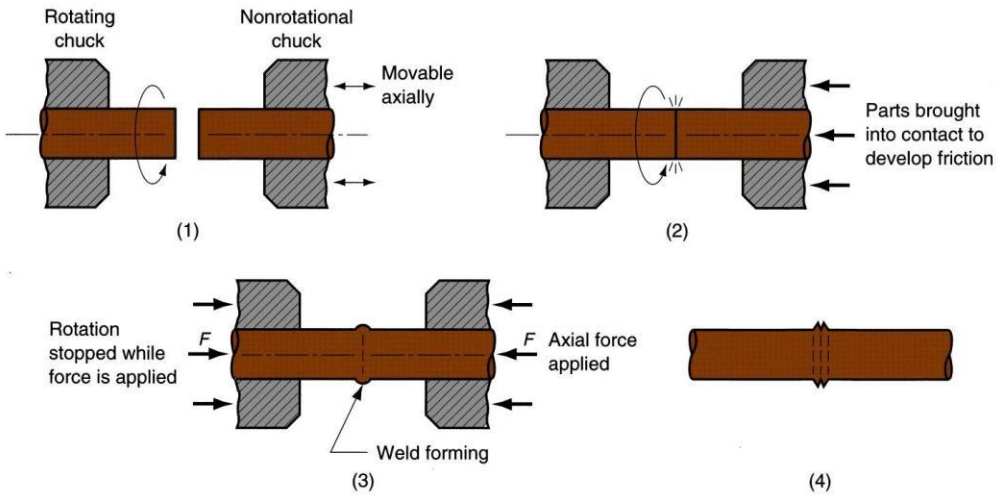


Fig: Friction welding (FRW): (1) rotating part, no contact; (2) parts brought into contact to generate friction heat; (3) rotation stopped and axial pressure applied; and (4) weld created.

Applications

- Shafts and tubular parts
- Industries: automotive, aircraft, farm equipment, petroleum and natural gas

Limitations

- At least one of the parts must be rotational
- Flash must usually be removed
- Upsetting reduces the part lengths (which must be taken into consideration in product design)

Weld Defects

- Undercuts/Overlaps
- Grain Growth

A wide ΔT will exist between base metal and HAZ. Preheating and cooling methods will affect the brittleness of the metal in this region

- Blowholes

Are cavities caused by gas entrapment during the solidification of the weld puddle. Prevented by proper weld technique (even temperature and speed)

- Inclusions

Impurities or foreign substances which are forced into the weld puddle during the welding process. Has the same effect as a crack. Prevented by proper technique/cleanliness.

- Segregation

Condition where some regions of the metal are enriched with an alloy ingredient and others aren‟t. Can be prevented by proper heat treatment and cooling.

- Porosity

The formation of tiny pinholes generated by atmospheric contamination. Prevented by keeping a protective shield over the molten weld puddle.

UNIT - 2

PART – A (2 Marks)

1. Define welding process.
2. Define fusion welding .
3. What are different method of welding you know ?
4. Define arc crater.
5. Mention any two advantages of D .C and A. C welding.
6. What do you under stand by straight polarity?
7. When is the straight polarity used for arc welding?
8. What is the purpose of coating on an arc – welding electrode?
9. What are the two main different of consumable electrode and non –consumable electrode?
10. How does MIG welding differ from TIG welding?
11. What is the main different between upset butt welding and flash butt welding ?
12. What are the various types of flame?
13. Define plasma arc welding ?

Part-B (16 Marks)

1. Explain the method of laser beam welding and give their applications (16)
2. Explain the method of electron beam welding and given their applications (16)
3. Describe plasma Arc welding and given their applications. (16)
4. Describe and explain Ultrasonic welding and give their applications. (16)
5. Explain Thermit welding and given their applications. (16)
6. What is frication welding? give their advantage and limitations. (16)

7. Distinguish between brazing, soldering and welding. (16)
8. Write briefly on testing and inspection of welding. (16)
9. Describe brazing process and its types. (16)
10. What are the advantages and disadvantages and limitations of adhesive bonding. (16)

UNIT III BULK DEFORMATION PROCESSES

Cold working

The process is usually performed at room temperature, but mildly elevated temperatures may be used to provide increased ductility and reduced strength

For example: Deforming lead at room temperature is a hot working process because the recrystallization temperature of lead is about room temperature.

Effects of Cold Working

Deformation using cold working results in

- Higher stiffness, and strength, but
- Reduced malleability and ductility of the metal.
- Anisotropy

Advantages

- No heating is required
- Strength, fatigue and wear properties are improved through strain hardening
- Superior dimensional control is achieved, so little, if any, secondary machining is required
- Better surface finish is obtained
- Products possess better reproducibility and interchangeability
- Directional properties can be imparted
- Contamination problems are minimized

Disadvantages

- Higher forces are required to initiate and complete the deformation
- Less ductility is available
- Intermediate anneals may be required to compensate for the loss of ductility that accompanies strain hardening
- Heavier and more powerful equipment is required
- Metal surfaces must be clean and scale-free
- Imparted directional properties may be detrimental
- Undesirable residual stresses may be produced

Hot working

Hot working is the deformation that is carried out above the recrystallization temperature.

Effects of hot working

· At high temperature, scaling and oxidation exist. Scaling and oxidation produce undesirable surface finish. Most ferrous metals needs to be cold worked after hot working in order to improve the surface finish.

· The amount of force needed to perform hot working is less than that for cold work.

· The mechanical properties of the material remain unchanged during hot working.

· The metal usually experiences a decrease in yield strength when hot worked. Therefore, it is possible to hot work the metal without causing any fracture.

Quenching is the sudden immersion of a heated metal into cold water or oil. It is used to make the metal very hard. To reverse the effects of quenching, tempering is used (reheated of the metal for a period of time)

To reverse the process of quenching, tempering is used, which is the reheat of the metal.

Cold-working Processes

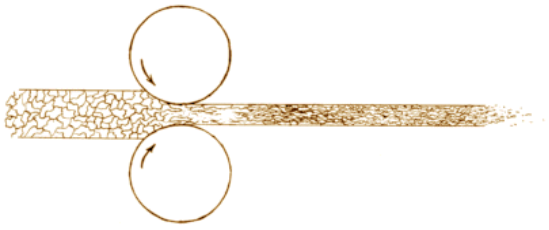
- Squeezing
- Bending
- Shearing
- Drawing
- Presses

Classifications of Squeezing Processes

- Rolling
- Cold Forging
- Sizing
- Staking
- Staking
- Coining
- Burnishing
- Extrusion
- Peening
- Hubbing
- Riveting
- Thread Rolling

ROLLING

Process used in sheets, strips, bars, and rods to obtain products that have smooth surfaces and accurate dimensions; most cold-rolling is performed on four-high or cluster-type rolling mills



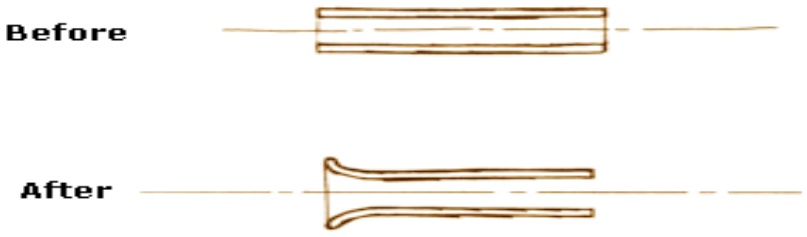
ROLLING PROCESS

Flat Rolling

A sheet or block or strip stock is introduced between rollers and then compressed and squeezed. Thickness is reduced. The amount of strain (deformation) introduced determines the hardness, strength and other material properties of the finished product.
Used to produce sheet metals predominantly

Swaging

Process that reduces/increases the diameter, tapers, rods or points round bars or tubes by external hammering



SWAGING

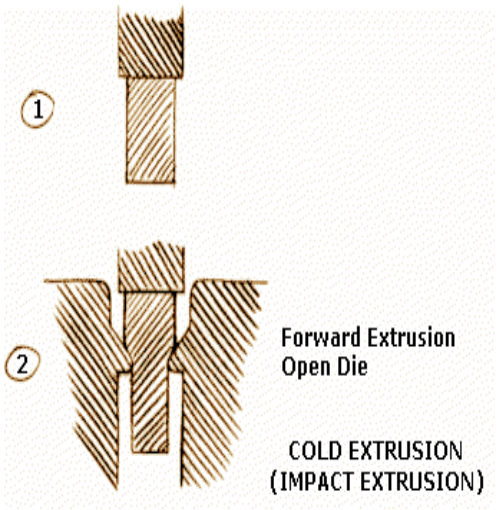
Cold Forging

Process in which slugs of material are squeezed into shaped die cavities to produce finished parts of precise shape and size.

COLD HEADING/COLD FORGING

Extrusion

Process which is commonly used to make collapsible tubes such as toothpaste tubes, cans usually using soft materials such as aluminum, lead, tin. Usually a small shot of solid material is placed in the die and is impacted by a ram, which causes cold flow in the material.



Sizing

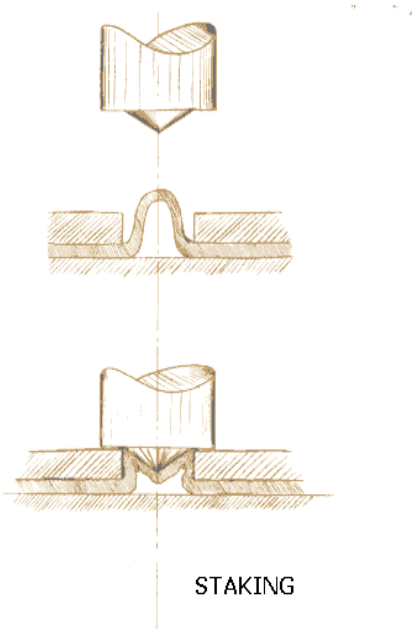
Process of squeezing all or selected areas of forgings, ductile castings, or powder metallurgy products to achieve a desired thickness or precision

Riveting

Process where a head is formed on the shrank end of a fastener to permanently join sheets or plates of material;

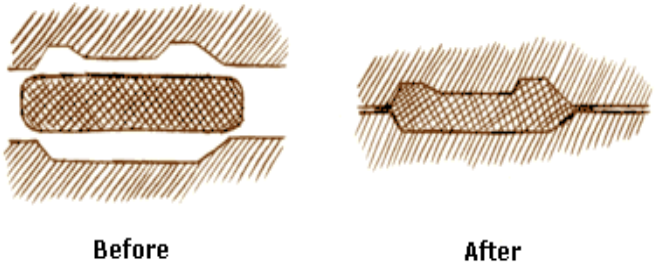
Staking

Process of permanently joining parts together when one part protrudes through a hole in the other; a shaped punch is driven into the end of the protruding piece where a deformation is formed causing a radial expansion, mechanically locking the two pieces together



Coining

Process where metal while it is confined in a closed set of dies; used to produce coins, medals, and other products where exact size and fine details are required, and thickness varies about a well-defined average



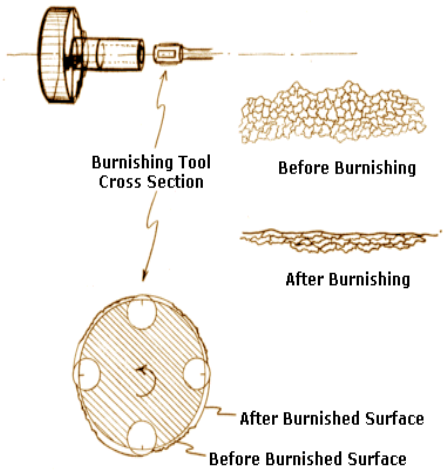
COINING

Peening

Process where the surface of the metal is blasted by shot pellets; the mechanical working of surfaces by repeated blows of impelled shot or a round-nose tool

Burnishing

Process by which a smooth hard tools is rubbed on the metal surface and flattens the high spots by applying compressive force and plastically flowing the material



BURNISHING

Hubbing

Process is used to form recessed cavities in various types of female tooling dies. This is often used to make plastic extrusion dies in an economical manner

Thread Rolling

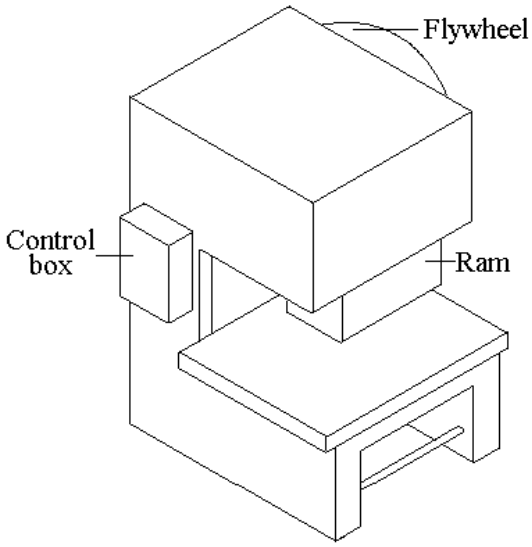
Process is used for making external threads; in this process, a die, which is a hardened tool with the thread profile, is pressed on to a rotating workpiece

THREAD ROLLING

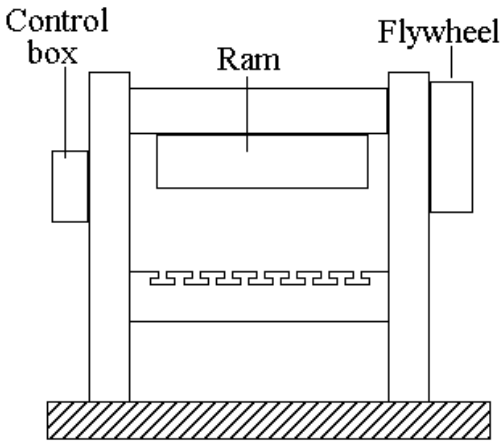
The Presses

There are many kinds of machines

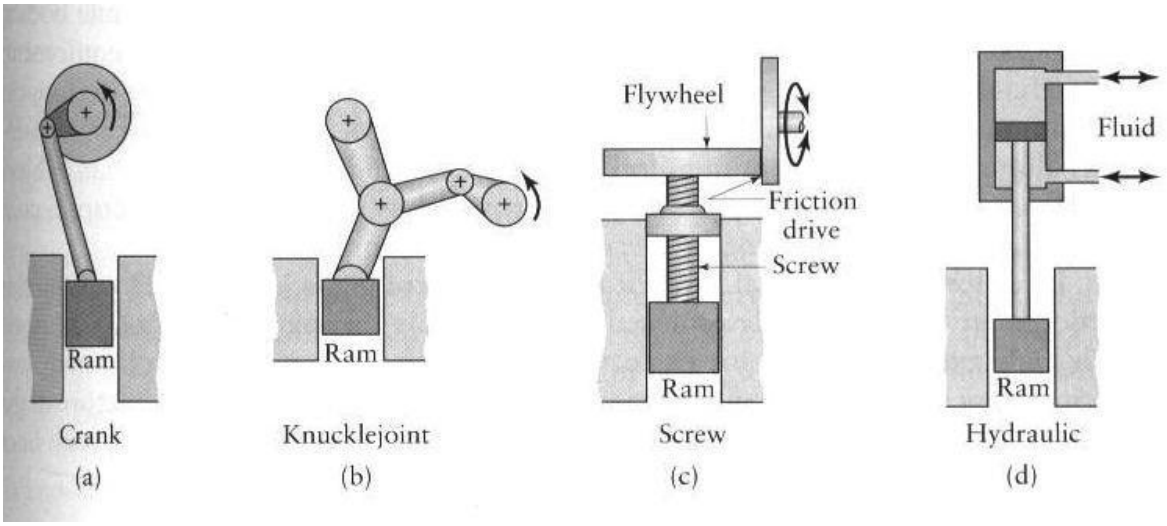
- Hydraulic presses
- Mechanical presses
  - C frame
  - Straight sided
- Others



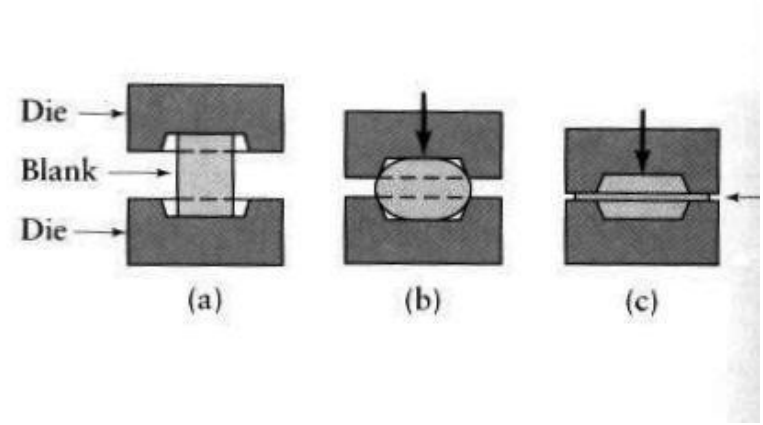
C-frame mechanical press



Types of Forging Presses



Impression Die Forging



Forging operations

Forging is a process in which the workpiece is shaped by compressive forces applied through various dies and tools. It is one of the oldest metalworking operations. Most forgings require a set of dies and a press or a forging hammer.

A Forged metal can result in the following: -

- Decrease in height, increase in section - open die forging
- Increase length, decrease cross-section, called drawing out.
- Decrease length, increase in cross-section on a portion of the length - upsetting
- Change length, change cross-section, by squeezing in closed impression dies - closed die forging. This results in favorable grain flow for strong parts

Types of forging

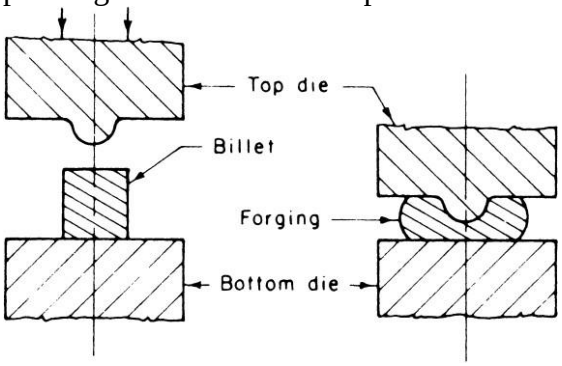
- Closed/impression die forging
- Electro-upsetting
- Forward extrusion
- Backward extrusion
- Radial forging
- Hobbing
- Isothermal forging
- Open-die forgig
- Upsetting
- Nosing
- Coining

Commonly used materials include

- Ferrous materials: low carbon steels
- Nonferrous materials: copper, aluminum and their alloys

Open-Die Forging

Open-die forging is a hot forging process in which metal is shaped by hammering or pressing between flat or simple contoured dies.



Equipment. Hydraulic presses, hammers.

Materials. Carbon and alloy steels, aluminum alloys, copper alloys, titanium alloys, all forgeable materials.

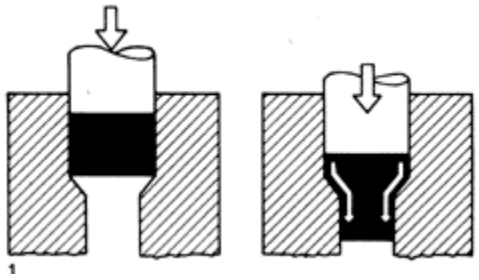
Process Variations. Slab forging, shaft forging, mandrel forging, ring forging, upsetting between flat or curved dies, drawing out.
Application. Forging ingots, large and bulky forgings, preforms for finished forgings.

Closed Die Forging

In this process, a billet is formed (hot) in dies (usually with two halves) such that the flow of metal from the die cavity is restricted. The excess material is extruded through a restrictive narrow gap and appears as flash around the forging at the die parting line.
Equipment. Anvil and counterblow hammers, hydraulic, mechanical, and screw presses.
Materials. Carbon and alloy steels, aluminum alloys, copper alloys, magnesium alloys, beryllium, stainless steels, nickel alloys, titanium and titanium alloys, iron and nickel and cobalt super alloys.
Process Variations. Closed-die forging with lateral flash, closed-die forging with longitudinal flash, closed-die forging without flash.
Application. Production of forgings for automobiles, trucks, tractors, off-highway equipment, aircraft, railroad and mining equipment, general mechanical industry, and energy-related engineering production.

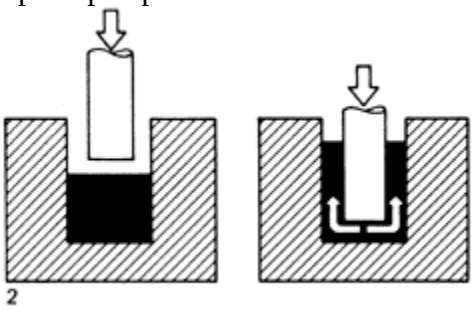
Forward extrusion

Forward extrusion reduces slug diameter and increases its length to produce parts such as stepped shafts and cylinders.



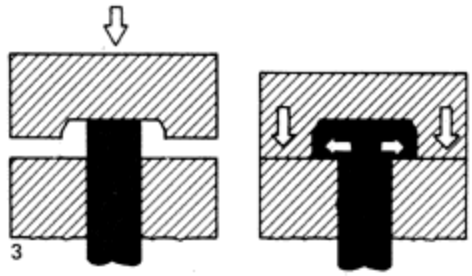
backward extrusion

In backward extrusion, the steel flows back and around the descending punch to form cup-shaped pieces.



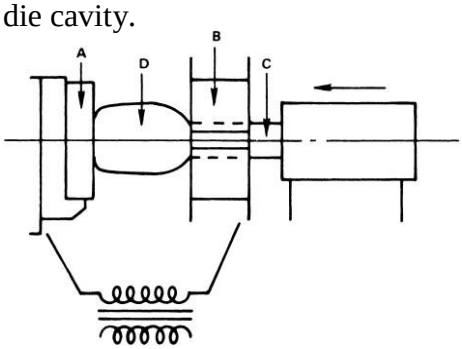
Upsetting, or heading

Upsetting, or heading, a common technique for making fasteners, gathers steel in the head and other sections along the length of the part.



Electro-Upsetting (Fig. 2.4)

Electro-upsetting is the hot forging process of gathering a large amount of material at one end of a round bar by heating the bar end electrically and pushing it against a flat anvil or shaped die cavity.



A, anvil electrode; B, gripping electrode; C, workpiece; D, upset end of workpiece

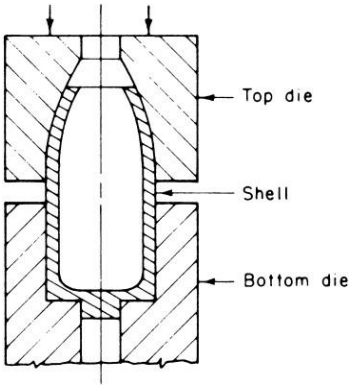
Equipment. Electric upsetters.
Materials. Carbon and alloy steels, titanium.
Application. Preforms for finished forgings.

Hobbing

Hobbing is the process of indenting or coining an impression into a cold orhot die block by pressing with a punch.
Equipment. Hydraulic presses, hammers.
Materials. Carbon and alloy steels.
Process Variations. Die hobbing, die typing.
Application. Manufacture of dies and molds with relatively shallow impressions.

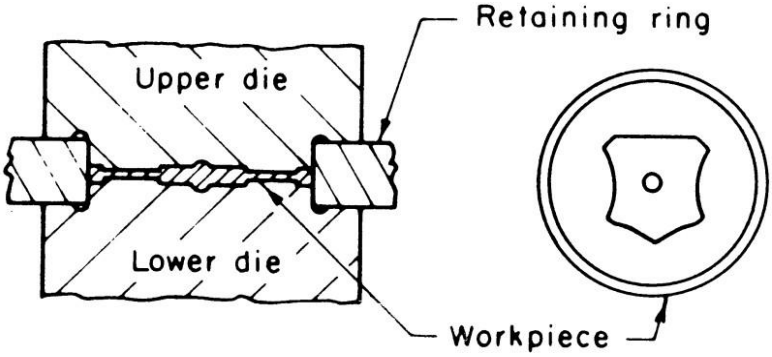
Nosing

Nosing is a hot or cold forging process in which the open end of a shell or tubular component is closed by axial pressing with a shaped die.
Equipment. Mechanical and hydraulic presses, hammers.
Materials. Carbon and alloy steels, aluminum alloys, titanium alloys.
Process Variations. Tube sinking, tube expanding.
Applications. Forging of open ends of ammunition shells; forging of gas pressure containers.



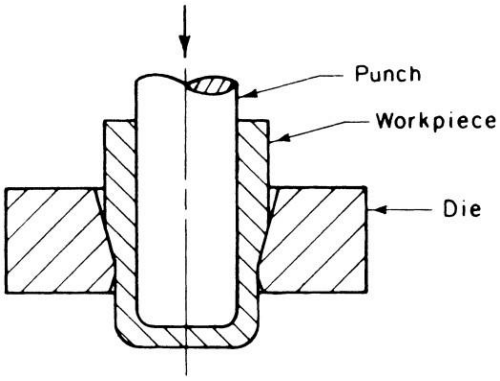
Coining

In sheet metal working, coining is used to form indentations and raised sections in the part. During the process, metal is intentionally thinned or thickened to achieve the required indentations or raised sections. It is widely used for lettering on sheet metal or components such as coins. Bottoming is a type of coining process where bottoming pressure causes reduction in thickness at the bending area.



Ironing

Ironing is the process of smoothing and thinning the wall of a shell or cup (cold or hot) by forcing the shell through a die with a punch.



Equipment. Mechanical presses and hydraulic presses.
Materials. Carbon and alloy steels, aluminum and aluminum alloys, titanium alloys.
Applications. Shells and cups for various

Swaging

Uses hammering dies to decrease the diameter of the part

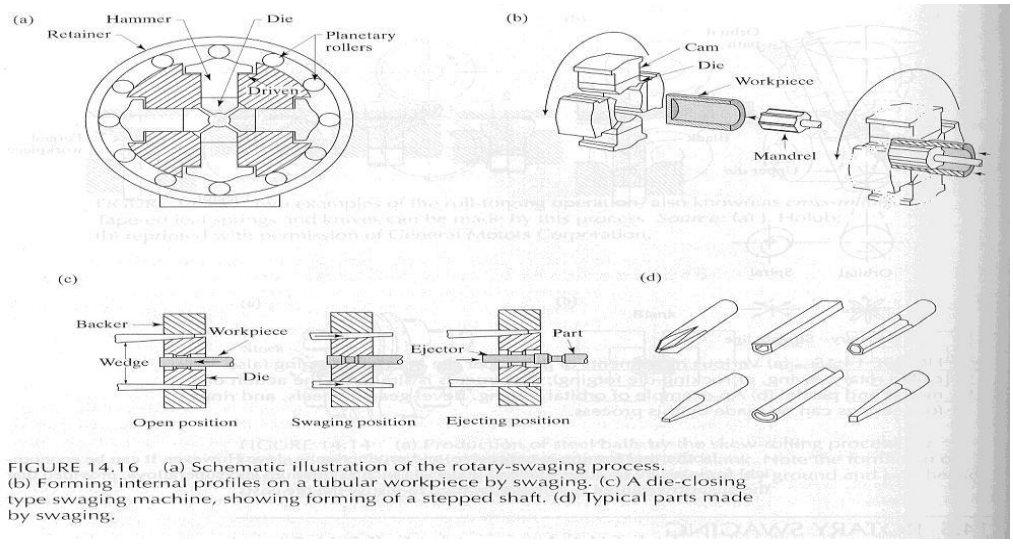
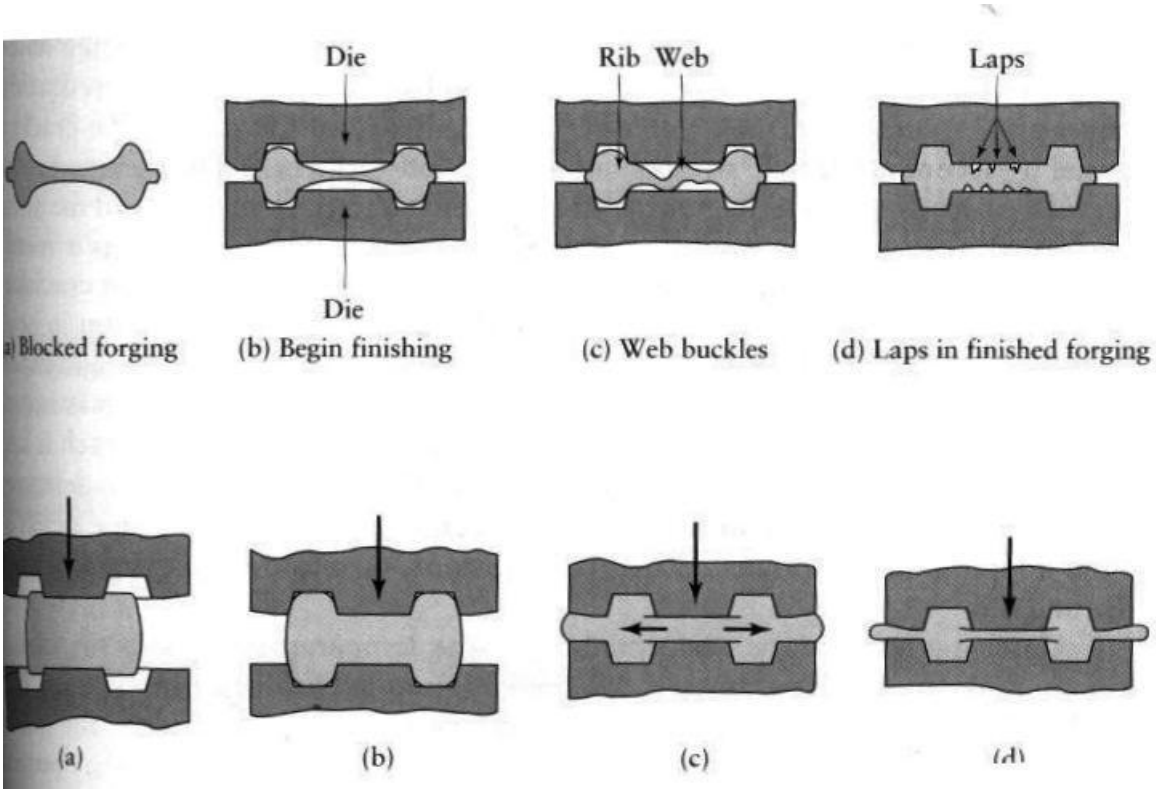


FIGURE 14.16 (a) Schematic illustration of the rotary-swaging process. (b) Forming internal profiles on a tubular workpiece by swaging. (c) A die-closing type swaging machine, showing forming of a stepped shaft. (d) Typical parts made by swaging.

Defects in Forging



Extrusion and Drawing Processes

Extrusion

Process by which long straight metal parts can be produced.
Cross-sections that can be produced vary from solid round, rectangular, to L shapes, T Shapes, tubes and many other different types
Done by squeezing metal in a closed cavity through a die using either a mechanical or hydraulic press.
Extrusion produces compressive and shear forces in the stock.
No tension is produced, which makes high deformation possible without tearing the metal.
Can be done Hot or cold

Drawing

Section of material reduced by pulling through die.
Similar to extrusion except material is under TENSILE force since it is pulled through the die
Various types of sections: - round, square, profiles

Tube Drawing

Utilizes a special tool called a MANDREL is inserted in a tube hollow section to draw a seamless tube

- Mandrel and die reduce both the tube's outside diameter and its wall thickness. The mandrel also makes the tube's inside surface smoother

UNIT-III

Part-A (2 Marks)

1. Define cold working of metals
2. Define re crystallization temperature
3. Give some examples for mechanical working of metals
4. Define forging
5. Give some basic forging operations
6. Define extrusion ratio
7. Define tube drawing
8. Define degree of drawing
9. Name four different press-working operations
10. What are the defects in forging operations?

Part-B (16 Marks)

1. Explain the hot working and cold working with suitable examples. (16)
2. Define rolling and discuss according to the classification. (16)
3. Discuss the various forging operations and its types. (16)

4. (i)Give the advantage of press forging over drop forging. (8)

(ii)Discuss closed die forging and open die forging. (8)

5. What are the defects in forgings? Explain it. (16)

6. How the pipe and tubes are manufacturing? (16)

7. Define drawing and discuss the classification with neat sketch. (16)

8. What are the defects in rolled parts? (16)

9. Explain the flat strip rolling process. (16)

10. Explain the shape rolling process. (16)

UNIT IV SHEET METAL PROCESSES

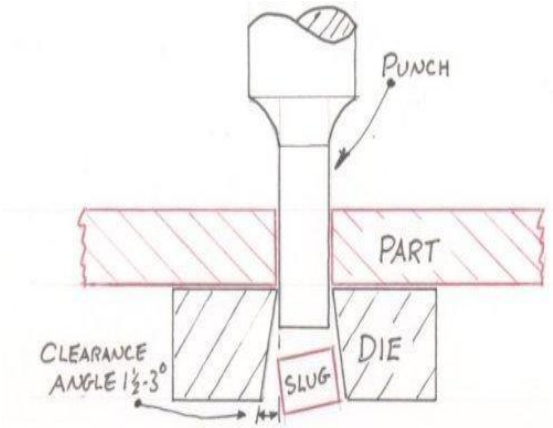
Sheet Metal Forming

Involves methods in which sheet metal is cut into required dimensions and shape; and/or forming by stamping, drawing, or pressing to the final shape
A special class of metal forming where the thickness of the piece of material is small compared to the other dimensions
Cutting into shape involve shear forces
Forming Processes involve tensile stresses

The Major operations of sheet Metal are;
1) Shearing,
2) Bending,
3) Drawing and
4) Squeezing

Shearing

The mechanical cutting of materials without the information of chips or the use of burning or melting for straight cutting blades: shearing for curved blades: blanking, piercing, notching, trimming

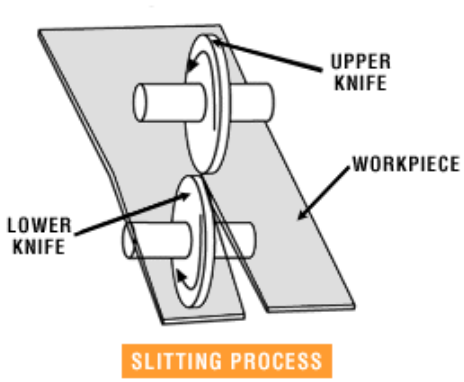


Classifications of Shearing Processes

- Slitting
- Piercing
- Blanking
- Notching
- Shaving
- Trimming
- Cutoff
- Dinking

Slitting

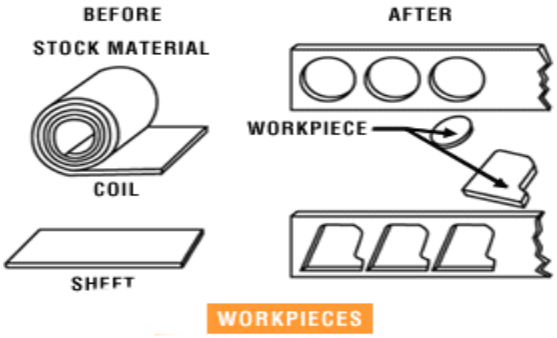
shearing process used to cut rolls of sheet metal into several rolls of narrower width
used to cut a wide coil of metal into a number of narrower coils as the main coil is moved through the slitter.



SLITTING PROCESS

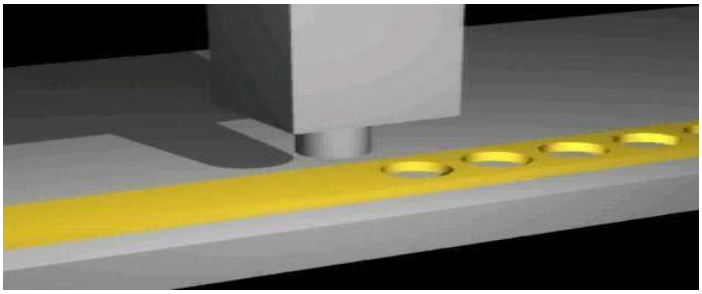
Blanking

during which a metal workpiece is removed from the primary metal strip or sheet when it is punched.



WORKPIECES

Piercing



Notching

same as piercing
- edge of the strip or black forms part of the punch-out perimeter

Nibbling

Produces a series of overlapping slits/notches

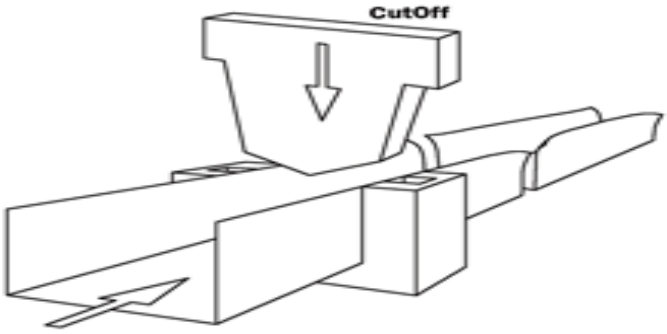
Shaving

- finishing operation in which a small amount of metal is sheared away from the edge of an already blanked part
- can be used to produce a smoother edge

Trimming

Cutoff

Punch and die operation used to separate a stamping or other product from a strip or stock



Dinking

Used to blank shapes from low-strength materials such as rubber, fiber and cloth

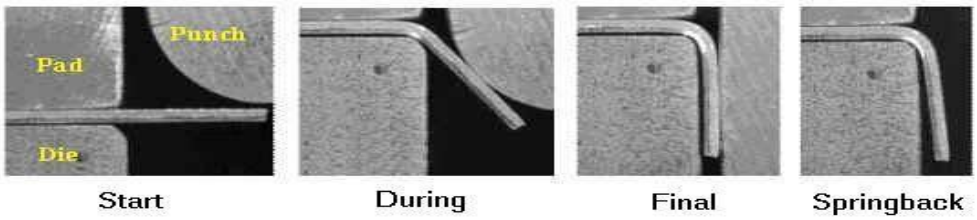
Bending

The plastic deformation of metals about a linear axis with little or no change in the surface area.

The purpose of bending is to form sheet metal along a straight line

Springback

The elastic recovery of the material after unloading of the tools



To compensate with the unbending action of the springback, the metal should be slightly overbent.

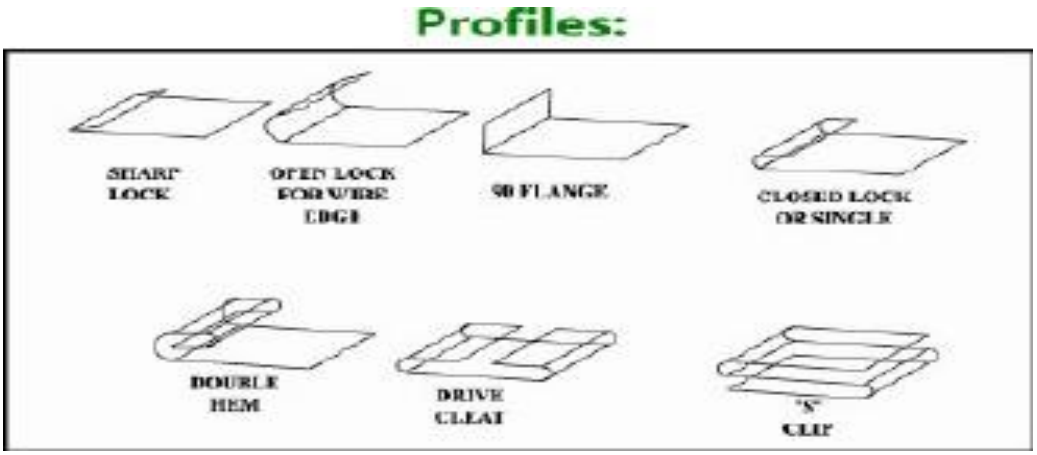
Classifications of Bending Processes

- Angle
- Straightening
- Roll Forming
- Draw and Compression
- Seaming
- Roll
- Flanging

Roll Bending

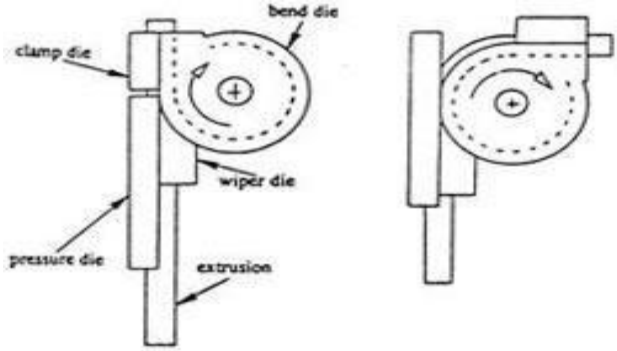
Bending where plates, sheets and rolled shapes can be bent to a desired curvature Roll bending toll can bend plate up to 6 inches thick

Angle Bending



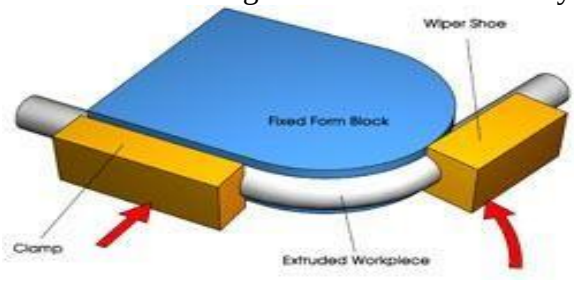
Drawing Bending

Workpiece is clamped against a bending form and the entire assemble rotates to draw the workpiece across a stationary tool



Compression Bending

The bending form remains stationary and the pressure tool moves along the workpiece



Roll Forming

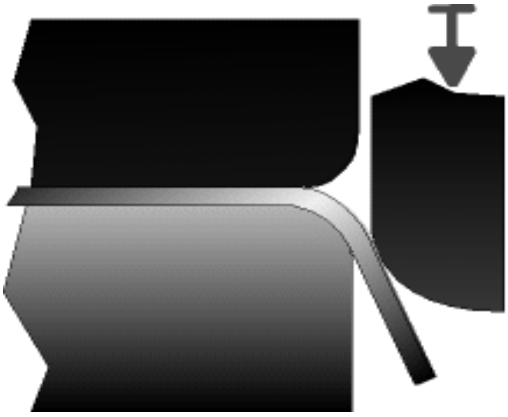
Involves the progressive bending of metal strip as it passes through a series of forming rolls
Any material that can be bent can be roll- formed

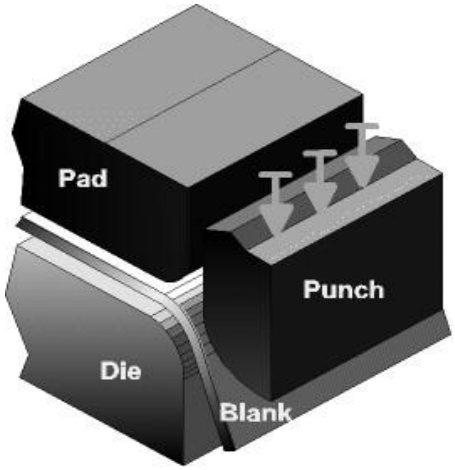
Seaming

- bending operation that can be used to join the ends of sheet metal to form containers such as cans, pails and drums

Flanging

-the process of rolling on sheet metal in essentially the same manner as seaming





Straightening

- also known as flattening
- opposite of bending

Drawing- Stretch forming

Sheet metal clamped along its edges and stretched over a die or form block in required directions.

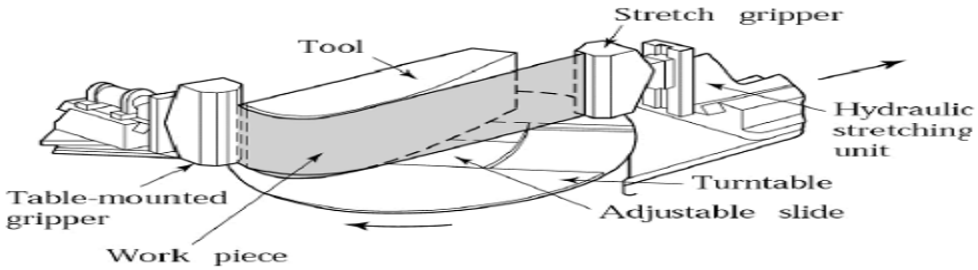


Fig: Schematic illustration of a stretch forming process. Aluminum skins for aircraft can be made by this process

Special Forming Process

There are a great variety of sheet metal forming methods, mainly using shear and tensile forces in the operation.

- Progressive forming
- Rubber hydroforming
- Bending and contouring
- Spinning processes
- Explosive forming
- Shearing and blanking
- Stretch forming
- • Deep drawing

Progressive forming

• Punches and dies are designed so that successive stages in the forming of the part are carried out in the same die on each stroke of the press.
• Progressive dies are also known as multi-stage dies.

Rubber forming

In bending and embossing of sheet metal, the female die is replaced with rubber pad

Hydro-form (or) fluid forming process

The pressure over rubber membrane is controlled throughout the forming cycle ,with max pressure up to 100 Mpi

As a result the friction at the punch-cup interface increases, this increase reduces the longitudinal tensile stresses in the cup and delays fracture

Spinning

Shaping thin sheets by pressing them against a form with a blunt tool to force the material into a desired form

Conventional spinning

A circular blank if flat or performed sheet metal hold against a mandrel and rotated ,while a rigid metal is held against a mandrel and rotated ,wile a rigid tool deforms and shapes the material over the mandrel.

Shear Spinning

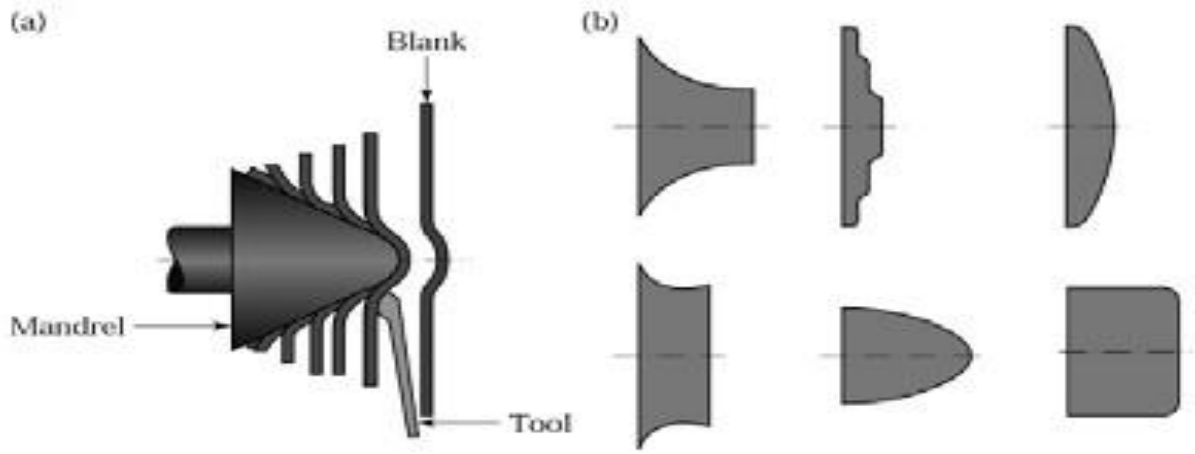
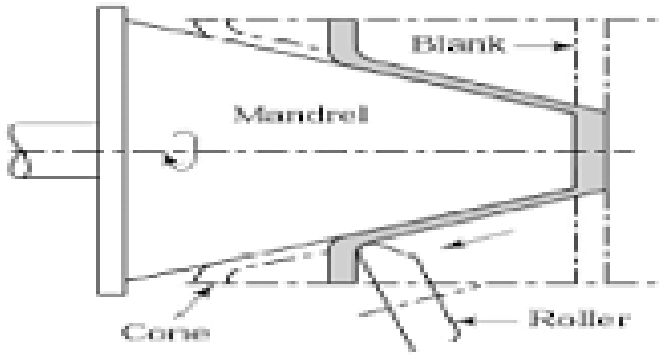


Fig .(a) Schematic illustration of the conventional spinning process (b) Types of parts conventionally spun.

All parts are antisymmetric

- Known as power spinning, flow turning, hydro-spinning, and spin forging
- Produces axisymmetric conical or curvilinear shape
- Single rollers and two rollers can be used
- It has less wastage of material
- Typical products are rocket-

motor casing and missile nose cones.

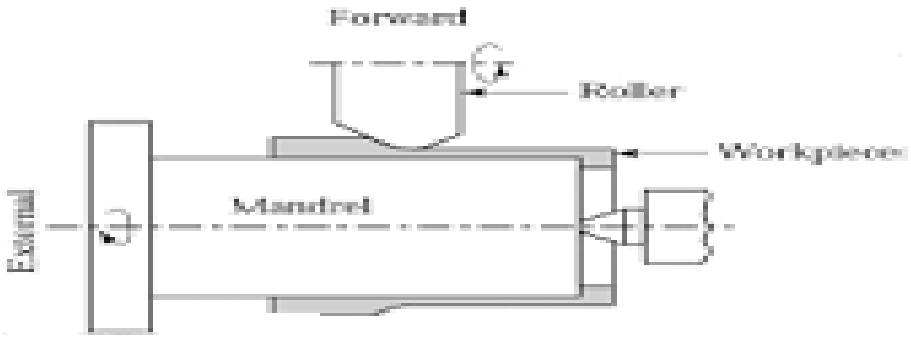


Tube spinning

Thickness of cylindrical parts are reduced by spinning them on a cylindrical mandrel rollers

Parts can be spun in either direction

Large tensile elongation up to 2000 % are obtained within certain temperature ranges and at low strain rates.



Advantages

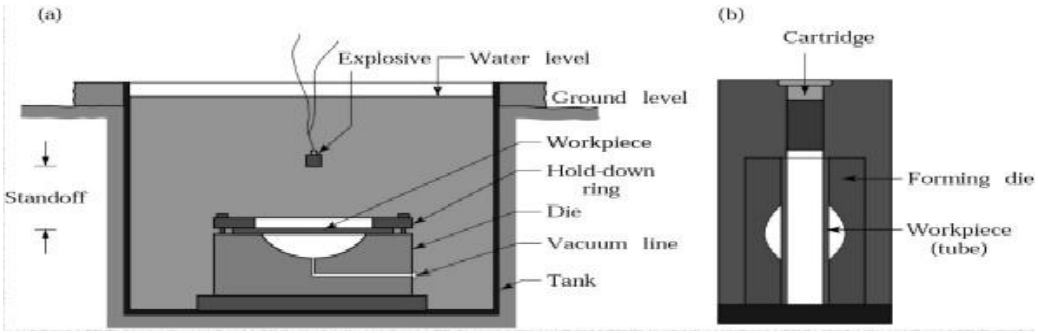
Lower strength is required and less tooling costs
Complex shapes with close tolerances can be made
Weight and material savings
Little or no residual stress occurs in the formed parts

Disadvantages

Materials must not be super elastic at service temperatures
Longer cycle times

Explosive forming

Explosive energy used s metal forming
Sheet-metal blank is clamped over a die
Assembly is immersed in a tank with water
Rapid conversion of explosive charge into gas generates a shock wave .the pressure of this wave is sufficient to form sheet metals



Beading

The periphery if the sheet metal is bent into the cavity of a die

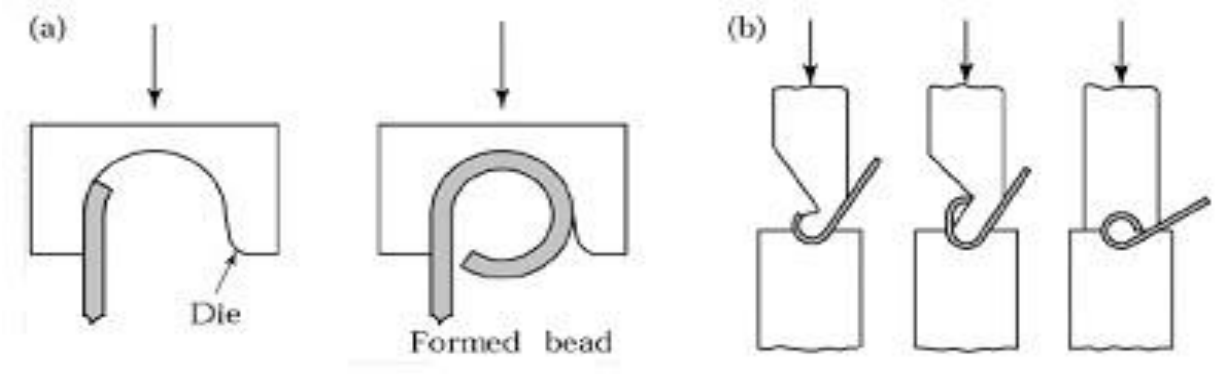


Fig .(a) Bead forming with a single die (b) Bead forming with two dies,in a press brake

Hemming

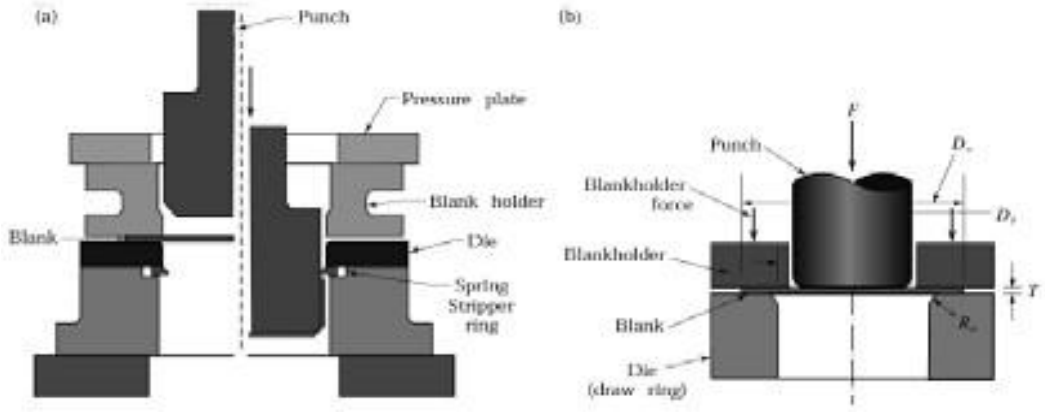
- The edge of the sheet is folded over itself
- This increases stiffness of the part
- The metal strip is bent in stages by passing it through a series of rolls

Seaming

Joining two edges of sheet metal by hemming.Specifically shaped rollers used for watertight and airtight joints

Deep drawing

- Punch forces a flat sheet metal into a deep die cavity.
- Round sheet metal block is placed over a circular die opening and held in a place with blank holder & punch forces down into the die cavity



Flanging

Flanging is a process of bending the edges of sheet metals to 90o
Shrink flanging – subjected to compressive hoop stress.
Stretch flanging –subjected to tensile stresses

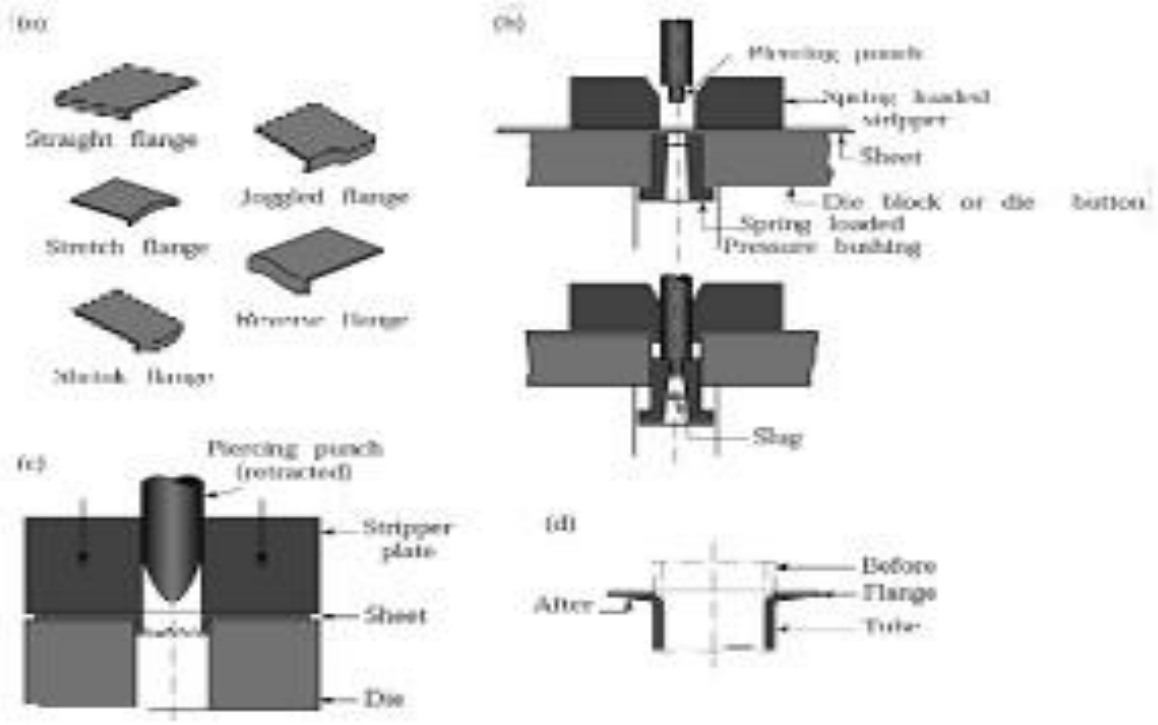


Fig .Various flanging operations (a) Flanges on a flat sheet. (b) Dimpling. (c) The piercing of the sheet metal to form a flange.
In this operation,a hole does not have to be prepunched before the bunch descends .Note however,the rough edges along the circumference of the flange. (d) The flanging of a tube; note the thinning of the edges of the flange

UNIT-IV

Part-A (2 Marks)

1. What is sheet metal work?
2. write down any four sheet metal characteristics
3. What is meant by clearance?
4. What is stretching?
5. Define the term “spring back”.
6. How force exerted on the form block is calculated
7. What are the formability test methods?
8. How special forming process is defined?
9. What is super plasticity of metals?

Part-B (16 Marks)

1. Describe shearing operations in a sheet metal work with a neat sketch. (16)

2. Describe various types of bending operations with its neat sketches. (16)

3. Explain any one method of stretch forming operation with a neat sketch. (16)

4. Explain hydro forming process with its neat sketches. State their advantage and applications. (16)

5. Explain the power spinning process with a neat sketch .give their applications. (16)

6. How magnetic pulse forming process is carried out on sheet metal? (16)

7. Explain peen forming process with a neat sketch. (16)

8. What is super plastic of metal? how this process is carried out on sheet metals? (16)

9. What is stretch forming ?How it is carried out in sheet metal? (16)

10. Write short notes on super plastic forming materials. (16)

UNIT V MANUFACTURING OF PLASTIC COMPONENTS

Common Polymers

ABS (Acrylanitrile Butadiene Styrene)
Amorphous, good Impact Strength, excellent appearance, easy to process, computer housings, small appliances, automotive interior, & medical components

Acrylic
Amorphous polymers, excellent clarity, excellent weatherability, optical & outdoor applications

Cellulosics
Among the first thermoplastics developed: smell funny, very flammable

Nylon 6
Semi-crystalline polymer, good cost to performance ratio, lower numbered nylons, absorb moisture and change their properties as a result

Polycarbonate
Amorphous material, excellent Impact Strength, clarity, & optical properties

Polyethylene High Density
widely used, inexpensive, thermoplastic, easy to process, good to excellent chemical resistance, soft & not for use above 150 F.

Polypropylene
semi-crystalline material, low temperature material, excellent chemical resistance difficult to mold to extremely close tolerances

Polystyrene High Impact (HIPS)
few cents more than crystal styrene, to pay for the rubber modifier, opaque & very widely used, lower modulus, better elongation, & less brittle than crystal styrene

PVC Polyvinyl Chloride Rigid
properties similar to ABS (except appearance) at a slightly reduced cost primarily for water pipe and pipe fittings, occasionally for electrical enclosures *in plastic phase PVC is corrosive to molds & machines (non corrosive as a solid)

Characteristics of Forming and Shaping Processes for Plastics and Composite Materials

TABLE 18.1

Process	Characteristics
Extrusion	Long, uniform, solid or hollow complex cross-sections; high production rates; low tooling costs; wide tolerances.
Injection molding	Complex shapes of various sizes, eliminating assembly; high production rates; costly tooling; good dimensional accuracy.
Structural foam molding	Large parts with high stiffness-to-weight ratio; less expensive tooling than in injection molding; low production rates.
Blow molding	Hollow thin-walled parts of various sizes; high production rates and low cost for making containers.
Rotational molding	Large hollow shapes of relatively simple shape; low tooling cost; low production rates.
Thermoforming	Shallow or relatively deep cavities; low tooling costs; medium production rates.
Compression molding	Parts similar to impression-die forging; relatively inexpensive tooling; medium production rates.
Transfer molding	More complex parts than compression molding and higher production rates; some scrap loss; medium tooling cost.
Casting	Simple or intricate shapes made with flexible molds; low production rates.
Processing of composite materials	Long cycle times; tolerances and tooling cost depend on process.

Plastics

Materials that can be reshaped (remolded) by applying heat and pressure. Most plastics are made from synthetic resins (polymers) through the industrial process of polymerization. Two main types of plastics are thermoplastics and thermosets.

Two basic types of plastics

Thermoset- Heat hardening/ Undergoes chemical change
Thermoplastic- Heat softening/ Undergoes physical change

1.Thermosets

General properties: more durable, harder, tough, light.
Typical uses: automobile parts, construction materials

Examples:

Unsaturated Polyesters: lacquers, varnishes, boat hulls, furniture
Epoxies and Resins: glues, coating of electrical circuits, composites: fiberglass in helicopter blades, boats, …

2. Elastomers

General properties: these are thermosets, and have rubber-like properties.
Typical uses: medical masks, gloves, rubber-substitutes

Examples:

Polyurethanes:mattress, cushion, insulation, toys
Silicones:surgical gloves, oxygen masks in medical applications joint seals

3. Thermoplastics

General properties: low melting point, softer, flexible.

Typical uses: bottles, food wrappers, toys, …

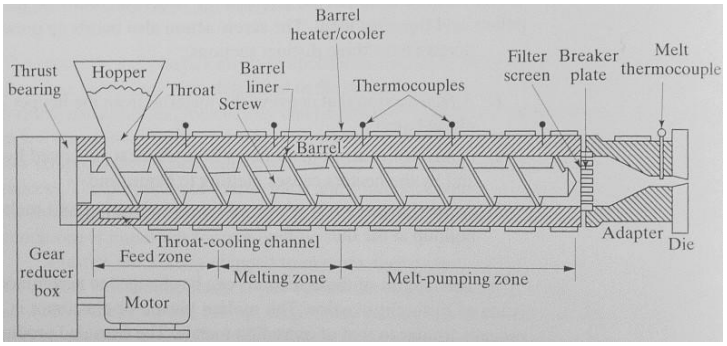
Examples:
Polyethylene: packaging, electrical insulation, milk and water bottles, packaging film
Polypropylene: carpet fibers, automotive bumpers, microwave containers, prosthetics
Polyvinyl chloride (PVC): electrical cables cover, credit cards, car instrument panels
Polystyrene: disposable spoons, forks, Styrofoam™
Acrylics (PMMA: polymethyl methacrylate): paints, fake fur, plexiglass
Polyamide (nylon): textiles and fabrics, gears, bushing and washers, bearings
PET (polyethylene terephthalate): bottles for acidic foods like juices, food trays
PTFE (polytetrafluoroethylene): non-stick coating, Gore-Tex™ (raincoats), dental floss

Advantages
Light Weight
High Strenght-to-Weight Ratio
Complex Parts - Net Shape
Variety of Colors (or Clear)
Corrosion Resistant
Electrical Insulation
Thermal Insulation
High Damping Coefficient
"Low" pressures and temp required

Disadvantages
Creep
Thermally Unstable- Can‟t withstand Extreme Heat
U-V Light Sensitive
Relatively low stiffness
Relatively low strength
Difficult to Repair/Rework
Difficult to Sort/Recycle

Plastic Manufacturing Processes
A wide variety of plastic manufacturing processes exist

- Extrusion
- Lamination (Calendering)
- Thermal Forming
- Foaming
- Molding
- Expansion
- Solid-Phase Forming
- Casting
- Spinning



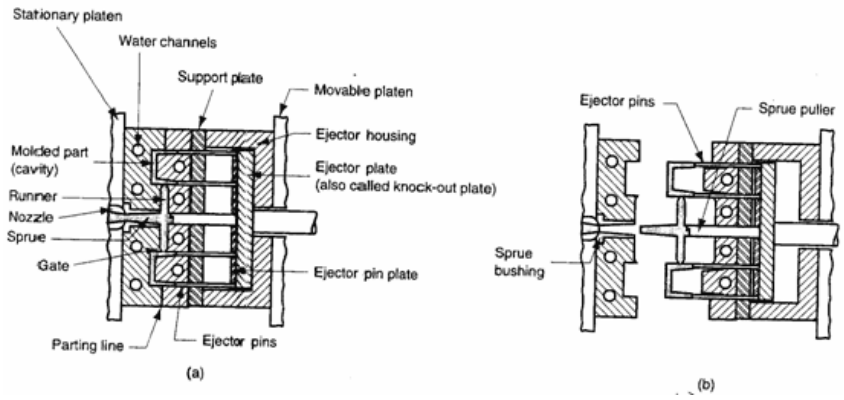
Injection Molding

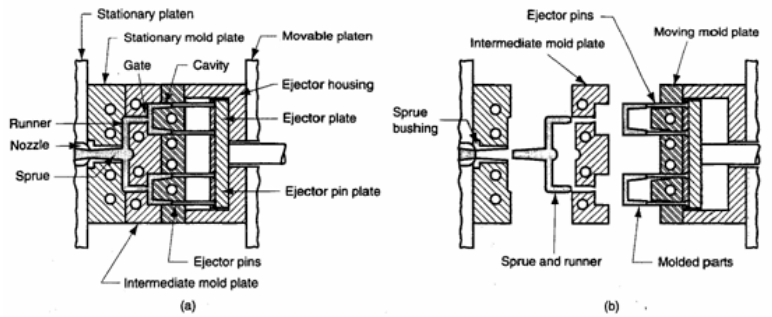
Most widely used process. Suitable for high production of thermoplastics. Charge fed from a hopper is heated in a barrel and forced under high pressure into a mold cavity. Several types. Variety of parts can be made.

Basic components:

mold pieces (define the geometry of the part), and sprue, gates, runners, vents, ejection pins, cooling system

Injection Molding: 2-piece and 3-piece molds





Designing injection molds

1. molding directions --- number of inserts/cams required, if any
2. parting lines

3. parting planes --- by extending the parting line outwards
4. gating design --- where to locate the gate(s) ?
5. multiple cavity mold --- fix relative positions of the multiple parts
6. runners: flow of plastic into the cavity
7. sprue located:
8. functional parts of the mold
- ejection system: to eject the molded part
- systems to eject the solidified runners
- alignment rods: to keep all mold components aligned

Considerations in design of injection molded parts

The two biggest geometric concerns
(i) proper flow of plastic to all parts of the mold cavity before solidification
(ii) shrinking of the plastic resulting in sink holes

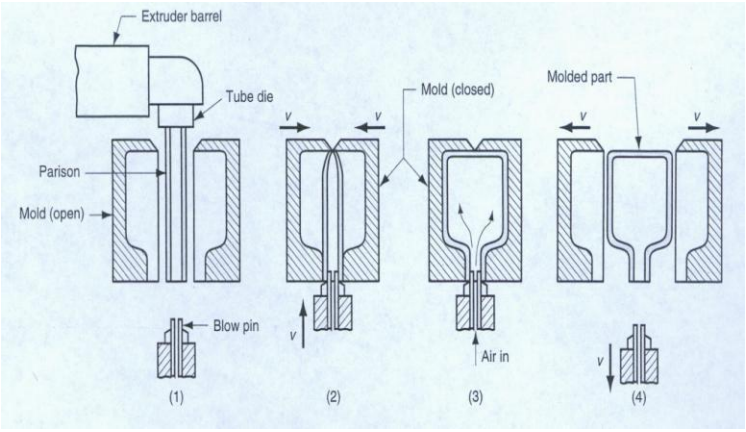
Blow Molding

used to make thermoplastic bottles and hollow sections. Starting material is a round heated solid-bottom hollow tube – perform.

Perform inserted into two die halves and air is blown inside to complete the process

General steps

- Melting the resin- done in extruder
- Form the molten resin into a cylinder or tube (this tube is called parison)
- The parison is placed inside a mold, and inflated so that the plastic is pushed outward against the cavity wall
- The part is allowed to cool in the mold and is then ejected
- The part is trimmed



The parison can be formed by

A)Extrusion process

B)Injection molding process

a)Extrusion blow molding

– Parison is formed from by forcing the plastic through an extrusion die.

- Material enters the die, flow around the mandrel so that extrudate would be cylindrical
- The die would have a hole at the center so that air could be blown into the cylinder
- In some blow molding operations, the air is introduced from the bottom through an inlet

This process can be;

- continuous extrusion blow molding
  - During the process, the extrusion runs continuously, thus making a continuous parison.
  - using multiple mold to match the mold cycle to the extrusion speed
- Intermittent extrusion blow molding
  - During the process, the extruder is stopped during the time that the molding occur
  - use either reciprocating screw or an accumulator system

- In this system, the output of the extruder is matched by having multiple molds which seal and blow the parison and then move away from extruder to cool and eject
- In practical case, the mold cycle is longer than time required to extrude a new parison
- If the mold cycle is twice than time needed for creating a parison, a two mold system can be used
- The method is sometimes called rising mold system - system of which two or more molds are used to mold parts from one extruder during continuous process

b) Injection Blow Molding

- The parison is formed by the injection of molten resin into a mold cavity and around a core pin
- The parison is not a finished product, but it is subjected to subsequent step to form the final shape
- Second step, blowing of the intermediate part in a second mold
- Because of distinct separation of the two steps, the parison made by injection molding is called a perform

Process

- The mold is closed
- Resin is then injected to form a cylindrical part
- The mold is opened and perform is ejected

The perform can be stored until the finished blow molded is needed.

The flexibility of separating the two cycles has proven useful in manufacture of soda pop bottle.

Comparison of extrusion and injection blow molding

Extrusion blow molding

- It is best suited for bottle over 200g in weight, shorter runs and quick tool changeover
- Machine costs are comparable to injection blow molding
- Tooling costs are 50% to 75% less than injection machine

- It requires sprue and head trimming
- Total cycle is shorter than injection (since the parison and blowing can be done using the same machine)
- Wider choice of resin
- Final part design flexibility

Injection blow molding

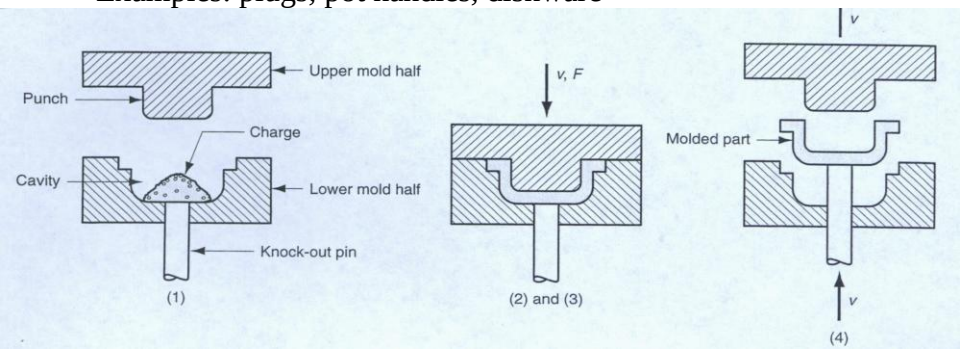
- Best suited for long runs and smaller bottles
- No trim scrap
- Higher accuracy in final part
- Uniform wall thickness
- Better transparencies with injection blow molding, because crystallization can be better controlled
- Can lead to improve mechanical properties from improved parison design.

Common plastics for blow molding

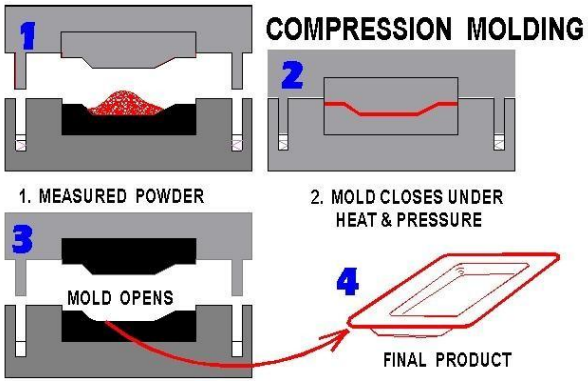
- HDPE (stiff bottle, toys, cases, drum)
- LDPE (flexible bottle)
- PP (higher temperature bottle)
- PVC (clear bottle, oil resistant containers)
- PET (soda pop bottle)
- Nylon (automotive coolant bottle, power steering reservoir)

Compression Molding

- The process of molding a material in a confined shape by applying pressure and usually heat.
- Almost exclusively for thermoset materials
- Used to produce mainly electrical products
  Thermoset granules are "compressed" in a heated mold to shape required.
  Examples: plugs, pot handles, dishware



Process



Transfer Molding

- A process of forming articles by fusing a plastic material in a chamber then forcing the whole mass into a hot mold to solidify.
- Used to make products such as electrical wall receptacles and circuit breakers
- Similar to compression molding except thermosetting charge is forced into a heated mold cavity using a ram or plunger.
  Examples: electrical switchgear, structural parts

Process Variables

- Amount of charge
- Molding pressure
- Closing speed
- Mold temperature
- Charge temperature
- Cycle time

Advantages

- Little waste (no gates, sprues, or runners in many molds)
- Lower tooling cost than injection molding
- Good surface finish
- Less damage to fibers
- Process may be automated or hand-operated
- Material flow is short, less chance of disturbing inserts, causing product stress, and/or eroding molds.

Disadvantages

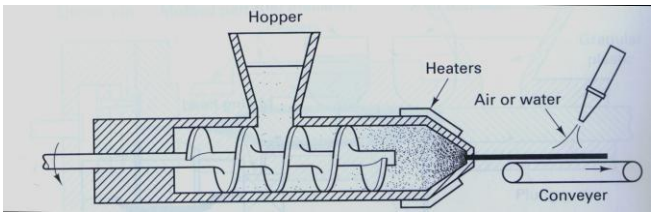
- High initial capital investment
- Labor intensive
- Secondary operations maybe required
- Long molding cycles may be needed.

Cold Molding

Charge is pressed into shape while cold then cured in an oven. Economical but usually poor surface finish

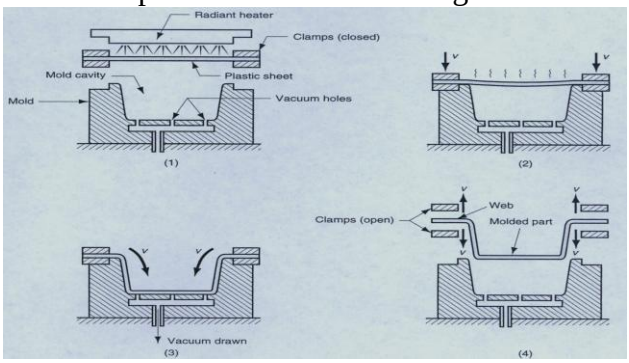
Extrusion

Extrusion is the process of squeezing metal in a closed cavity through a tool, known as a die using either a mechanical or hydraulic press.
Similar to injection molding except long uniform sections are produced –e.g. pipes, rods, profiles.
Extrusion often minimizes the need for secondary machining,and as a result could result in financial savings. However extruded objects are not of the same dimensional accuracy or surface finish as machined parts.



Thermoforming

Sheet material heated to working temperature then formed into desired shape by vacuum suction or pressure. Suitable for large items such as bath tubs



Rotational Molding

Used to form hollow seamless products such as bins. Molten charge is rotated in a mold in two perpendicular axes simultaneously, or rotated while tilting.

Foam Molding

Foaming agent is combined with the charge to release gas, or air is blown into mixture while forming.

Used to make foams. Amount of gas determines the density

Calendaring:

Molten plastic forced between two counter-rotating rolls to produce very thin sheets e.g. polyethylene sheets

Spinning

Modified form of extrusion in which very thin fibers or yarns are produced

Machining

Material removal process such as drilling, turning, thread cutting. E.g. nylon fasteners. In general thermoplastics have poor machinability**.**

Pressure Forming

It is nothing more than Vacuum Forming with pressure assist to the forming process to enable crisper detail and sharper features. Pressure Forming utilizes pressurized air to push the heated sheet into the cavity. Pressure formed parts can resemble the detail of injection molded parts at a fraction of the tooling cost.

Vacuum Forming

It is accomplished by heating the plastic sheet until it is pliable enough to be vacuumed either into a female mold or over a male mold.

UINT-V

PART-A (2 Marks)

1. How the plastic is defined?
2. Give some examples of additives
3. Give some examples for thermosetting plastics.
4. Give some example of thermo plastics.
5. Give some additives added to the manufacturing of rubber.
6. What are the processes of thermoplastics?
7. What are the two types of injection moulding?
8. What are the types of compression moulding?
9. define co polymerization
10. What are the foamed plastics?

Part-B (16 Marks)

1. What are the characteristics of the forming and shaping processes? (16)
2. What are the types of moulding and thermoplastics? (16)
3. Explain the working principles and application of injection moulding. (4)

a. blow moulding . (4)

b. rotational moulding. (4)

c. film blowing . (4)

4. Explain the thermoforming process. (16)
5. Explain induction and ultrasonic methods. (16)
6. Explain working and principle of applications of compression moulding. (8)

a. transfer moulding. (8)

7.What is bonding of thermo plastics?Explain. (16)

8.What are the fusion and solvent methods? (16)

9.Explain induction and ultrasonic methods. (16)

University Question Bank

Model 1

Part – A (2 x 10 = 20)

1.Mention the specific advantages of carbon di oxide process?

2. Write the composition of good moulding sand?

3.Define welding process.

4. Define fusion welding .

5.Define forging

6. Give some basic forging operations

7.What is stretching?

8. Define the term “spring back”.

9.What are the types of compression moulding?

10. define co polymerization.

Part- B(5 x 16 = 80)

11.State the different type of mould. Write a short note on „Green sand mould‟ and shell moulding (16) OR

12. Write a neat sketch of a cupola, Explain its operate. (16)

13. Explain the method of electron beam welding and given their applications OR

14. (i)Give the advantage of press forging over drop forging. (8)

(ii)Discuss closed die forging and open die forging. (8)

15. What are the defects in forgings? Explain it. (16) OR

16. Describe various types of bending operations with its neat sketches. (16)

17. Explain any one method of stretch forming operation with a neat sketch. (16) OR

18. Explain the working principles and application of injection moulding. (4)

a. blow moulding . (4)

b. rotational moulding. (4)

c. film blowing . (4)

19. Explain the thermoforming process. (16) OR

20. Explain induction and ultrasonic methods. (16)

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Coordinator, NPTEL