UNIT –I

ENGINEERING ETHICS

Syllabus: 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.

SENSES OF 'ENGINEERING ETHICS'

The word ethics has different meanings but they are correspondingly related to each other. In connection with that, Engineering ethics has also various senses which are related to one another.

Comparison of the senses of Ethics and Engineering Ethics

Ethics	Engineering Ethics
1. Ethics is an activity which concerns with making investigations and knowing about moral values, finding solutions to moral issues and justifying moral issues and justifying moral judgments. 2. Ethics is a means of contrasting moral questions from non-moral problems. 3. Ethics is also used as a means of describing the beliefs, attitudes and habits related to an individual's or group's morality. Eg. : Ethics given in the Bhagavat Gita or the Bible or the Quran. 4. As per the definition of dictionaries – 'moral principles' is about the actions and principles of conduct of the people. i.e. ethical or unethical.	1. Like the ethics, engineering ethics also aims at knowing moral values related to engineering, finding accurate solutions to the moral problems in engineering and justifying moral judgments of engineering. 2. Engineering Ethics gives a total view of the moral problems and how to solve these issues specifically related to engineering field. 3. Engineering ethics is also using some currently accepted codes and standards which are to be followed by group of engineers and engineering societies. 4. Engineering ethics also concerns with discovering moral principles such as obligation, rights and ideals in engineering and by applying them to take a correct decision.

From these senses of Engineering ethics, one can realize that it is the study of morality.

What is morality?

The term ‘morality’ concerns with (a) what ought or ought not to be done in a given situation, (b) what is right or wrong in handling it, (c) what is good or bad about the persons, policies and principles involved in it.

If an action is said to be morally right or a principle is said to be morally good, then they are said to be had some moral reasons in supporting it.

Moral reasons include respecting others and ourselves, respecting the rights of others, keeping promises, avoiding unnecessary problems to others and avoiding cheating and dishonesty, showing gratitude to others and encourage them to work.

So, if an engineering decision is said to be a good one, it has to meet out all the specifications. These specifications must be covered both the technical and the moral specifications such as safety of the product, reliability, easy maintenance and the product should be user-friendly with environment.

VARIETY OF MORAL ISSUES

There are so many engineering disasters which are greater / heavier than the level of acceptable or tolerable risk. Therefore, for finding and avoiding such cases such as nuclear plant accident at Chernobyl (Russia), Chemical plant at Bhopal (India) where a big disaster of gas leakage, occurred in 1980, which caused many fatal accidents. In the same way, oil spills from some oil extraction plants (the Exxon Valdez plant), hazardous waste, pollution and other related services, natural disasters like floods, earth quake and danger from using asbestos and plastics are some more cases for engineering disasters. These fields should be given awareness of engineering ethics. Hence, it is essential for engineers to get awareness on the above said disasters. They should also know the importance of the system of engineering.

When malfunction of the system is a rapid one, the disaster will be in greater extent and can be noticed immediately. When they ate slow and unobserved, the impact is delayed. So, the engineers should not ignore about the functions of these systems.

These cases also explain and make the engineers to be familiar with the outline of the case in future and also about their related ethical issues.

Approaches to Engineering Ethics:

i. ***Micro-Ethics:*** This approach stresses more about some typical and everyday problems which play an important role in the field of engineering and in the profession of an engineer.

ii. ***Macro-Ethics:*** This approach deals with all the social problems which are unknown and suddenly burst out on a regional or national level.

So, it is necessary for an engineer to pay attention on both the approaches by having a careful study of how they affect them professionally and personally. The engineers have to tolerate themselves with the everyday problems both from personal and societal point of view.

Where and How do Moral Problems arise in Engineering?

Any product or project has to undergo various stages such as planning, idea, design, and manufacturing which is followed by testing, sales and services. This has to be done by engineers of various branches like Civil, Mechanical, Electrical, Chemical etc. These engineers may be grouped together as a team or they may be separated from each other with an interconnection or co-ordination.

Inspite of the engineers' full attention and care, sometimes the product or project may be unsafe or less useful. This may be due to some reasons 1) The product or project may be designed for early obsolescence or 2) due to under pressure because of running out of time, budgetary etc or 3) by ignorance on the size of the project, or 4) because of the large number of a products sold on the mass market, people may be affected.

Some cases with which different areas covered by engineering ethics:

1. An inspector finds a faulty part in the manufacture of a machine, which prevents the use of that machine for a longer period. But his superior, takes this as a minor mistake and orders that the faulty part to be adjusted so that the delay in the process has to be avoided. But the inspector doesn't want this and so he is threatened by the supervisor.
2. An electronic company applies for a permit to start a Nuclear Power Plant. When the licensing authority comes for visit, they enquire the company authorities on the emergency measures that have been established for safety of the surroundings. The engineers inform them about the alarm system and arrangements have been made in local hospitals for the treatment of their employees and they have no plan for the surrounding people. They also inform that it is the responsibility of the people.
3. A Yarn Dyeing company which dumps its wastes in the nearby river. It causes heavy damage to the people those who are using the river. The plant engineers

are aware of this, but they do not change the disposal method because their competitors also doing similarly as it happens to be a cheaper. They also say that it is the responsibility of the local government.

The above given examples clearly explain how the ethical problems arise most often because of wrong judgments and expectations of engineers. These necessitate for establishing some codes of conduct which has to be imposed on engineers' decisions on the basis of ethical view.

TYPES OF INQUIRY

Inquiry means an investigation. Like general ethics, Engineering ethics also involves investigations into values, meaning and facts. These inquiries in the field of Engineering ethics are of three types.

1. Normative Inquiries
2. Conceptual Inquiries
3. Factual or Descriptive Inquiries

Normative Inquiries

These inquiries are mostly helpful to identify the values which guide the individuals and groups in taking a decision. These are meant for identifying and justifying some norms and standards of morally desirable nature for guiding individuals as well as groups. In most of the cases, the normative questions are given below:

1. How do the obligations of engineers protect the public safety in given situations?
2. When should an engineer have to alarm their employers on dangerous practices?
3. Where are the laws and organizational procedures that affect engineering practice on moral issues?
4. Where are the moral rights essential for engineers to fulfill their professional obligations?

From these questions, it is clear that normative inquiries also have the theoretical goal of justifying moral judgments.

Conceptual Inquiries

These are meant for describing the meaning of concepts, principles, and issues related to Engineering Ethics. These inquiries also explain whether the concepts and ideas are expressed by single word or by phrases. The following are some of the questions of conceptual inquiries:

1. What is the safety and how it is related to risk?
2. What does it mean when codes of ethics say engineers should protect the safety, health and welfare of the public?
3. What is a ‘bribe’?
4. What is a ‘profession’ and ‘professional’?

Factual / Descriptive Inquiries

These help to provide facts for understanding and finding solutions to value based issues. The engineer has to conduct factual inquiries by using scientific techniques. These help to provide information regarding the business realities such as engineering practice, history of engineering profession, the effectiveness of professional societies in imposing moral conduct, the procedures to be adopted when assessing risks and psychological profiles of engineers. The information about these facts provide understanding and background conditions which create moral problems. These facts are also helpful in solving moral problems by using alternative ways of solutions.

These types of inquiries are said to be complementary and interrelated. Suppose an engineer wants to tell a wrong thing in an engineering practice to his superiors, he has to undergo all these inquiries and prepare an analysis about the problem on the basis of moral values and issues attached to that wrong thing. Then only he can convince his superior. Otherwise his judgment may be neglected or rejected by his superior.

MORAL DILEMMAS

Why study engineering ethics?

Engineering ethics is not only teaching moral behaviour in knowing about immoral and amoral in a set of beliefs, but also increasing the ability of engineers and other professionals to face boldly with the moral problems arising from technological advancements, changes and other related activities. This can be possible be imparted among the engineers, only through college courses, seminars, etc. which are involved individual study.

Moral Dilemmas

Dilemmas are certain kind of situations in which a difficult choice has to be made.

Moral dilemmas can also be called moral problems. Moral dilemmas have two or more foldings - moral obligations, duties, rights, goods or ideals come into disagreement with each other. One moral principle can have two or more conflicting applications for a particular given situation. Moral dilemmas can be occurred in so many ways. For example, suppose one gives a promise to his friend that he will meet him on the evening of a particular day, but unfortunately on the same day his brother has met with an accident and he has to take him to hospital. The dilemma here consists of a conflict between the duty to keep promise and obligations to his brother. In this situation, to solve his moral problem, he can make a phone call to his friend and make apology for his inability to come. So, from the above it is clear that the duty to keep promise always has two different and conflicting applications.

The moral dilemmas cannot easily be addressed or resolved always. It requires an elaborate searching which sometimes causing extreme suffering and reflection of a situation. The modern engineering practice compels that all the engineers have to face boldly about the moral dilemmas in their careers.

To find a simple and clear solution to the moral problems in the field of engineering, there must be some provision to allocate time to for learning ethics in engineering courses. But at the same time, it should not be ignored in the following three categories of complex and gloomy moral situations:

The Problem of Vagueness

The problem of vagueness is related to individuals. The individuals may not know how to moral considerations or principles in resolving a moral problem at a particular situation. For example, an engineer in a higher position of a company, is responsible and having the sole right to make purchases on his own and behalf of the company. There may be many suppliers for supplying materials. In this situation, a sales representative from one of the suppliers approaches him with a moderating gift. In this case, the engineer may have some doubts like (i) Whether this is an acceptance of a bribe? (ii) Does it create a conflict of interest? The solution is only with that engineer. He can also discuss with his colleagues about the problem. The colleague may find the solution on the basis of previous experiences, - it may not be a kind of bribe, but at the same time it should not be encouraged in future because there is the possibility of supplying substandard materials. It is difficult to arrive at the conclusion whether the gift is an innocent amenity or an unacceptable bribe.

The problems of Conflicting reasons

These occur more frequently. In a difficult situation of a moral problem, an individual may clearly know about what moral principle has to be applied to resolve the problem. When it arises, there are two or more principles with clear solutions lead into conflict with one another or one particular moral principle. Simultaneously there can be of two different directions. In this case, that individual has to choose a better one among them on the basis of the importance and the applicability. For example, an engineer has given a promise to his employer and another one to a colleague. If it is difficult to fulfill both the promises, he can drop off one promise which is of least importance. If he explains the situations to his colleagues, it can be understood.

The problems of disagreement

The individuals and groups in engineering companies may disagree with resolving moral problems in difficult situations. The disagreement will be normally about how to interpret, apply and balance the moral problems. In this situation they have to use the following steps to resolve the problems.

Steps / Procedures in facing / confronting moral dilemmas

All the above said three problems pave the way for the need of several steps in resolving the moral dilemmas. All the steps are interrelated and they can also be used jointly.

1) Identifying the relevant moral factors and reasons: i.e. Finding solutions for (i) the conflicting responsibilities (ii) the competing rights and (iii) the clashing ideals involved.
2) Collecting and gathering all the available facts which are relevant to the moral factors while resolving.
3) Ranking the moral considerations or principles on the basis of importance as applicable to the situation. But sometimes it is not possible when the objective is to find a way to meet equally urgent responsibilities and to promote equally important ideals.
4) Considering alternative courses of action for resolving the problems and tracing the full implications of each. i.e. conducting factual inquiries.
5) Having talked with the colleagues, friend about the problem getting their suggestions and alternative ideas on resolving that dilemma and
6) Arriving at a careful and reasonable judgment or solution by taking into consideration of all important moral factors and reasons on the basis of the facts or truths. But it seems to be difficult.

To conclude, only the study of Engineering Ethics can help in developing the skills and attitudes to follow the above steps in resolving a moral problem among the engineers and other professionals by means of case studies, class room discussions and debating.

MORAL AUTONOMY

Meaning and Causes

Autonomy means self-governing or self-determining i.e act independently. Moral autonomy means the right or the wrong conduct which is of independent on ethical issues. It deals with the improvement of an individual's moral thoughts which make hi to adopt good habits. Moral autonomy is concerned with the independent attitude of a person related to ethical issues. It helps to improve the self-determination among the individuals.

The need for moral autonomy in the field of engineering ethics

The objectives of engineering ethics are not related to implanting particular moral beliefs on engineers. In other way they help the engineers and other professionalists to strength their professional values such as honesty, respect the colleagues and think for the welfare of the general public. Though the above said values have been already in the minds of the engineers, engineering ethics helps to improve these qualities in a better manner among the engineers, and not inculcating newly. The structural objective of engineering ethics is to be enable the individuals to understand the moral responsibilities in a clear and careful manner. So, the main aim of studying engineering ethics is to increase the moral autonomy within him.

Moral autonomy is a skill and habit of thinking ethical problems in a rational manner. These ethical issues are to be found out on the basis of moral problems. These general responsiveness of moral values are derived only from the training what we have received as a child with response to the sensitive and right of others and ourselves. Suppose the training is not given in the childhood itself, those children may be ill-treated or neglected by the society. These children in future may grow up with lack of senses on moral issues and they become as sociopaths. They are never morally autonomous. They won't regret for their mistakes and wrong doings.

These moral concerns can be initiated or imparted among the engineers, mainly engineers of various subjects and also by the way of their friends, or by social events occurring around them or by books and movies. So the main aim of all the courses of Applied Ethics is only to improve their abilities in order to face the moral issues critically. This can only be achieved by improving the practical skills which are helping in producing effective independent or self-determination thoughts among the individuals about the moral problems.

Skills for improving moral autonomy

1. The engineers must have the competence for identifying the moral problems and ethical issues related to the field of engineering – they must have the ability to distinguish and relate these moral problems with the problems of law, economics, religions principles etc. They must possess the skills of understanding, clarifying and assessing the arguments which are against the moral issues.
2. They must have the ability to suggest the solutions to moral issues, on the basis of facts. These suggestions must be consistent and must include all the aspects of the problem.
3. They must have the imaginative skill to view the problems from all view points and also be able to suggest a proper alternative solution.
4. They must be able to tolerate while giving moral judgments and decisions which may cause trouble. i.e. they have to understand the difficulties in making moral decisions.
5. They must have adequate knowledge and understanding about the use of ethical language so as to defend or support their views with others.
6. They must have some better knowledge in understanding the importance of suggestions and better solutions while resolving moral problems and also about the importance of tolerance on some critical situations.
7. They must understand the importance of maintaining the moral honesty i.e. the personal convictions and beliefs and individual's professional life must be integrated. They must have this skill of doing so.

Conclusion

From the above decisions on moral autonomy, we can conclude that moral autonomy helps an engineer to increase his moral outlook in an appreciable manner. It also helps him to be morally responsible in his daily activities.

KOHLBERG'S THEORY

Moral Autonomy is based on the psychology of moral development. The first psychological theory was developed by Jean Piaget. On the basis of Piaget's theory, Lawrence kohlberg developed three main levels of moral development which is based on the kinds of reasoning and motivation adopted by individuals with regard to moral questions.

The Pre Conventional Level

It is nothing but self-centered attitude. In this level, right conduct is very essential for an individual which directly benefits him. According to this level, individuals are motivated by their willingness to avoid punishment, or by their desire to satisfy their own needs or by the influence of the power exerted by them. This level is related to the moral development of children and some adults who never want to go beyond a certain limit.

The Conventional Level

The level deals with the respect for conventional rules and authority. As per this level the rules and norms of one's family or group or society has been accepted as the final standard of morality. These conventions are regarded as correct, because they represent with authority. When individuals are under this level, always want to please/satisfy others and also to meet the expectations of the society and not their self-interest. Loyalty and close identification with others have been given much importance. No adult tries to go beyond this level.

The Post Conventional Level

This level is said to be attained when an individual recognizes the right and the wrong on the basis of a set of principles which governing rights and the general good which are not based on self-interest or social conventions. These individuals are called "autonomous", because they only think for themselves and also they do not agree that customs are always correct. They want to live by general principles which are universally applied to all people. They always want to maintain their moral integrity, self-respect and the respect for other autonomous peoples.

Kohlberg's theory of moral development is very much related to the goals of studying ethics at college level. To become morally responsible, an individual must be able and willing to undergo with moral reasoning. Moral responsibility comes out of the foundation of early moral training given by an individual's parents and culture. This early training helps to complete the above said three levels of moral development by an individual.

As per Kohlberg's view only few people would reach the post conventional level which is based on assumption that movement towards autonomous is morally desirable.

GILLIGAN'S THEORY

Gilligan's argument

Caorl Gilligan was one of the students of Kohlberg. She criticizes Kohlberg's theory on the basis of approached made by both male and female towards morality. On the basis of her studies and researches, she criticizes Kohlberg's theory which is only based on male bias and his studies are of typically male preoccupation with general rules and rights.

She also suggest that men are always more interested in resolving moral dilemmas by applying some most important moral rules. But women always want to keep up the personal relationship with all those involved in a situation and they always give attention only on the circumstances responsible for that critical situation and not on general moral rules.

She also states that Kohlberg's theory is only on ethics of rules and rights. But her theory is known as ethics of care. i.e. context oriented emphasis required to maintain the personal relationship.

Levels of Moral Development

Gilligan recasts Kohlberg's three levels of moral development on the basis of her own studies of women, as follows:

The Pre-Conventional Level

This is more over the same as Kohlberg's first level i.e. Right conduct is a selfish thing as solely one what is good for oneself.

The Conventional Level

This level differs from Kohlberg's second level. According to her, women don't want to hurt others and want to help others i.e. women always want to give up their interests in order to help the others to fulfill their needs.

The Post Conventional Level

This level is also differed from Kohlberg's level. In this level, individual (particularly women) want to balance between caring about other people and their interests. The main aim here is to balance an individual's needs with those of others on the basis of mutual caring. This can be achieved only through context-oriented reasoning and not by abstract rules.

Heinz's Dilemma

Gilligan's criticism on the Kohlberg's theory can be made very clear with the help of a famous example used by Kohlberg in his questionaries and interviews. This is called Heinz's Dilemma.

This example was about a woman and Heinz, her husband living in Europe. The woman was affected by cancer. The doctors told her to use an expensive drug to save her life. The pharmacist who also invented that medicine charged ten times the cost of making the drug. Besides his poverty, Heinz took a lot of effort to borrow money, but he could get only half of the amount needed. He approached to the pharmacist and begged him to sell the medicine at a cheaper price or allow him to pay for it later. But the pharmacist refused to do so. Finally, without any hope, Heinz forcibly entered into the pharmacy and stolen the drug. The question here is “Was the theft morally right or wrong?”

By asking this question among the male, Kohlberg has received two sets of answers: One is based on the conventional level i.e. Heinz did a wrong thing. Another one is based on the post conventional level i.e,Heinz was correct as the life of the wife is more important than the property right of the pharmacist.

But when the same question was asked among the women, they gave (all women) same answers. They replied that Heinz was wrong. They further told that instead of stealing the medicine, Heinz could have tried other alternative solutions. They also told that Heinz should have convinced still the pharmacist to get the medicine.

From the above, Kohlberg concluded that women’s decisions are always based on conventional rule and they always have different opinions in applying the general moral rules and principles about the right to live.

On the basis of the Kohlberg’s comment on the women, Gilligan came to a different conclusion. She tells that it shows greater sensitivity to people and personal relationships. She concluded that the decision taken by women is context-oriented and not on the basis of general rules ranked inorder of priority.

Now, the question here is, how Gilligan’s theory of moral development relates to moral autonomy as a goal of studying ethics at the college level?

Autonomy requires independent reasoning on the basis of moral concern and not separated from other people. As per Gilligan’s theory and Kohlberg’s theory, moral autonomy should be consistent with context-oriented and also with an awareness of general moral principles and rights.

CONSENSUS AND CONTROVERSY

Consensus means ‘agreement’ and ‘controversy’ means disagreement. The consensus and the controversies are playing the vital roles while considering the moral autonomy.

When an individual exercises the moral autonomy, he cannot get the same results as others get in applying moral autonomy. Surely there must be some moral differences i.e. the results or verdicts will be of controversy. This kind of disagreements is unavoidable. These disagreements require some tolerances among individuals those who are autonomous, reasonable and responsible.

As per the principle of tolerance, the goal of teaching engineering ethics is not merely producing an agreed conformity on applying moral principles among engineers but also to reveal the ways of promoting tolerances to apply moral autonomy.

Both the goals of engineering ethics and the goals of engineering courses have some similarities. These similarities have to be extended with the help of exercising authority. For example, in the class room, the teachers are having the authority over students and in the work place, the managers are having the authority over engineers.

There are two general points regarding the relationship between autonomy and authority with reference to the class room:

1) Moral autonomy and respect for the authority cannot be differentiated or separated from each other. Moral autonomy is exercised on the basis of moral concern for other people and also recognition of good moral reasons. Authority provides for the framework in which learning can take place. It is based on the acceptance of authority by both the students and the professors. Without this acceptance, the classes cannot be conducted in a smooth way. On the other hand, cheating will be encouraged and the trust between faculty and the students may be reduced to some extent. These kind of deviations are due to the absence of moral views and respect for authority. They must be coincide with each other.
2) Generally a tension may arise among the individuals regarding the need for consensus about authority and need for autonomy. This tension can be reduced by discussing openly regarding a moral issue between students and faculty with the help of the authority.

In short, conflicts will arise between autonomy and authority, when the authority is misused. For example, in small classes, the students are having the authority to express their own views. But when the professor doesn't allow them to do so, he misuses his authority. This will create some moral problems between the students and the faculty.

MODELS OF PROFESSIONAL ROLES

The main aim of the profession of engineering is to improve the public safety, wealth and welfare. In order to perform these functions, the engineer has to play various models to channalise his attitudes towards the achievements of objectives. They are as follows:

1. ***Savior***

   The engineers are responsible for creating an utopian society in which everything is possible and can be achieved without much effort – This can only be achieved through technological developments made by the engineers for safe-guarding the society from poverty, inefficiency, waste and manual labour.
2. ***Guardian***

   Engineers only know the directions through which technology will be developed. So, they should be given position of high authority based on their expertise skills in determining what is in the best interests of the society. They should act as guardians to the technological improvements.
3. ***Bureaucratic Servant***

   Engineer's role in the management is to be the servant who receives and translates the directive of management into better achievements. They have to solve the problems given by the management, within the limits set by the management.
4. ***Social Servant***

   The role of engineers is not only providing service to others but also their responsibility to the society. The interests of the society can be expressed to the engineers either directly or indirectly. So, the engineers, with the co-operation of the management have the work of receiving society's directives and satisfying the desires of the society.
5. ***Social enabler and Catalyst***

   The engineer has to play a role of creating a better society and should be the cause of making social changes. Service given by the engineers to the society includes carrying out the social directives. Engineers are needed to help the management and the society to understand their needs and to create decisions about technological development.
6. ***Game Player***

   We cannot say that engineers are servants or masters of anyone. They are playing the economic game rules which may be effective at a given time. Their aim is to play successfully within the organization enjoying the happiness of technological work and the satisfaction of winning and moving ahead in a completive world.

THEORIES ABOUT RIGHT ACTION

There are four types of theories on ethics, which help to create the fundamental principles of obligation suitable and applicable to professional and personal conduct of a person in his everyday life. These theories are essential for cause of right action and morality. They are:

1. ***"Golden mean"*** ethics (Aristotle, 384 – 322 B.C.). The best solution is achieved through reason and logic and is a compromise or "golden mean" between extremes of excess and deficiency. For example, in the case of the environment, the golden mean between the extremes of neglect and exploitation might be protection.

   Problem: Variability from one person to another in their powers of reasoning and the difficulty in applying the theory to ethical problems.

2. ***"Rights – based"*** ethics (John Locke, 1632 – 1704). Every person is free and equal and has the right to life, health, liberty and possessions (in effect prohibiting capital punishment, medical charges, jails and income taxes).

   Problem: One person's right may be in conflict with another's rights.

3. ***"Duty – based"*** ethics (Immanual Kant, 1724 – 1804). Each person has a duty to follow a course of action that would be universally acceptable for everyone to follow without exception. (Thus we would all be honest, kind, generous and peaceful).

   Problem: Universal application of a rule can be harmful.

4. ***"Utilitarian"*** ethics (John Stuart Mill, 1806 – 1873). The best choice is that which produces the maximum benefit for the greatest number of people (which could endanger minority rights).

   Problem: Qualification of the benefits can be difficult.

All these theories can be differentiated on the basis of what they provide for moral concept, good results for all, duties and human rights.

SELF – INTEREST, CUSTOMS AND RELIGION

Moral justifications and principles form a distinct category of value, which are different from other category of values. This can be more clear by relating and contrasting moral values to three other types of values namely self-interest, customs and religion. Focus must be made in each case, how we can reduce morality to these types of value.

Self –Interest and Ethical Egoism

Self-interest is nothing but one's personal good. It refers to the goodness of oneself in the long run.

Each of the ethical theories recognizes the importance of self-respect. Utilitarian considers one's own good as well as the good of others. Duty ethicists stresses duties to ourselves and for won well-being. Ethicists of rights emphasize our rights to pursue our own good. Virtue ethicists accent the importance of self – respect.

Each of these theories insists that the pursuit of self – interest must be balanced and kept under control by moral responsibilities to other people. Now let us consider a view called "ethical Egoism" which challenges all the ethical theories and it tries to reduce morality to the pursuit of self-interest. It is called 'egoism', because it says that the main duty of us is to maximize our own good. According to Thomas Hobbes and Any Rand, moral values are reduced to concern for oneself but always a rational concern which requires consideration of a person's long-term interests.

The Supporters of ethical egoism make a differentiation between narrower and wider forms of self-interest. When a person who selfishly preoccupies his own private good and disregard for the good of others, will be off from rewarding friendships and love. Personal well-being generally requires taking some large interest in others. But the rational egoist insists that the only reason for showing an interest in others is for the sake of oneself.

Ethical Egoists try to protect their positions by arguing that an ironic importance of everyone rationally pursuing one's self-interest is that every one get benefited. The society benefits mostly when (i) individuals pursue their private good and (ii) corporations pursue maximum profits in a competitive free market. The main idea here is that leads to the improvement of economy through which benefiting everyone.

Because, both the individual and the corporation know very well that what is good for them and how best to pursue that good.

As per ethical egoism, people should always and only pursue their self – interest in a very cautious manner to value the interest rationally on the basis of facts.

Morality essentially needs a willingness on the part of both individuals and corporations to place some restrictions on the pursuit of private self – interests. Accepting these constraints is presupposed in what is meant by moral concern Engineering Ethics also has one task of exhibiting the moral limits on the pursuit of self interest in the Engineering profession.

The above said remarks do not constitute a wrong proof for ethical egoism. Morality stresses that we have to give value and we are concerned for the good of other people. Ethical egoism is not a persuasive or probable theory to state what is morality but it is only a convinced rejection of morality.

Customs and Ethical Relativism

As we live in a society which is of increasingly diverse nature, it is more important to have tolerance for various customs and outlooks. Hence the concept of ethical pluralism emerges. It views that there may be alternative moral attitudes that are reasonable. But none of the moral perspectives can be accepted completely by all the rational and the morally concerned persons. Ethical pluralism allows the customs which plays an important role in deciding how we should act. Moral values are many, varied and flexible. So, these moral values allow considerable variation in how different individuals and groups understand and apply them in their day-today activities. In other words, to be precise, reasonable persons always have reasonable disagreement on moral issues, including issues in engineering ethics.

Ethical Relativism, an objectionable view, should not be confused with Ethical Pluralism. As per Ethical relativism says that actions are morally right when they are approved by law or custom and they are said to be wrong when they violate laws or customs. Ethical relativism tries to reduce moral values to laws, conventions and customs of societies.

What is the necessary for a person to accept ethical relativism? There are so many reasons for accepting ethical relativism –

I. The laws and customs seem to be definite, real and clear – cut. They help to reduce the endless disputes about right and wrong. Moreover, laws seem to be an objective way to approach values. The above argument is some what weak. This reason underestimates the extent to which ordinary moral reasons are sufficiently objective to make possible criticism of individual prejudice and bias. Moreover, moral reasons allow objective criticism of the given laws as morally inadequate. For example, the apartheid laws (racial segregation) in south Africa. This law violated the human rights are not given any legal protections to the majority of the blacks, but morally ought to be.

II. The second reason for accepting ethical relativism is because it believes the values are subjective at the cultural level. They also state that the moral standards are varied from one culture to another. The only kind of objectivity is relative to a given set of laws in a given society. This relativity of morality encourages the virtue of tolerance of difference among societies.

The above said argument is also confusing one. It assumes that ethical relativism is implied by descriptive relativism. i.e., values and beliefs differ from culture to culture. There is nothing self-certifying about the laws and beliefs. This can be explained by the following illustration. Ethical relativism would allow that Hitler and his followers (Nazis) acted correctly when they killed 6 million Jews, for their laws, customs, and beliefs which were based on anti – Semitism (hostile to Jews).

So, ethical relativism refers anything but for the tolerant doctrine it pretends to be. But there is nothing tolerant in accepting Nazi beliefs about morality Admitting intolerant anti-semitic beliefs is not an act of tolerance.

The supporters of ethical relativism, generally say that an action is right “for cultures” when believe it as the right one.i.e., it is right “for them” though not “for us”. So, beliefs, however customary or widely shared, are not self-certifying whether we are talking about moral beliefs or scientific beliefs.

The third reason is based on the moral relationalism or moral contextulaism. This states that moral judgments must be made in relation to some factors which varies from case to case. Making simple and absolute rules are impossible in this way. In most of the cases, customs and laws are considered as morally important factors for making judgments.

All philosophers accepted this moral relationalism. But contemporary duty and right ethicists like ‘Kant’ do not accept. As per their views, respecting people require some sensitiveness to special circumstances. The virtue ethicists stress the role of practical wisdom in identifying the facts which are relevant to assessment of conduct based on virtual manner.

The ethical relativism was accepted by early cultural anthropologists because they had a specified tendency to overstress the scope of moral difference between cultures. Absorbed with unusual practices such as head – hunting, human sacrifices and cannibolism (cannibal is a person who eats human flesh); these persons who shifted their idea quickly form moral views differ greatly to “Morality is a simply a culture as such”. But modern anthropologists states that all cultures by virtual show some commitment to promote social co-operation and protect their members against needless death and suffering. Moral differences are based only on the circumstances and facts, not on the difference in moral attitudes. For example, we can consider the practice of human sacrifice in the Aztecs. [Members of a former Indian people who ruled Mexico before the 16 th century]. This practice seems to be a sign of cruelty an lack of concern for life. But a full examination of their beliefs reveal that they believed their gods are pleased by such sacrifice to ensure the survival of their people and also it was considered an honour for the victims. Refer to the sacrifice or placing chicken and goal to god.

Religion and Divine Command Ethics

Moral responsibilities and religious belief are interwined in many positive ways. First, they are related historically. Our moral views have been shaped by the most known central moral values within the major world religions. For example, the Judeo-Christian tradition has been influential in Western countries like England, USA etc. Islam has been having a great influence in middle east countries such as Saudi Arabia, Kuwait, Pakistan etc. Confucianism has been influential in China and Buddhism, Hinduism and Taoism have been famous in Asian countries.

Second, most of the people still having beliefs and show some important and inevitable psychological connections between their moral and religious beliefs. Religious views frequently support moral responsibility by providing additional motivation for being moral. Faith in Religions or religious hopes imply trust. This trust gives an inspiration to be moral.

The main social functions of religion is motivating right action based on ethical principles. Religion supports many people to follow their beliefs and promote tolerance and moral concern for others. Many of the engineers are motivated by the religious beliefs.

Thirdly, religions form a set of higher moral standards. For example, Christianity suggests for loving neighbors. Many religions include virtue ethics that stresses about particular virtues. For example, the ethics if Christianity focuses in the virtue of hope, faith and love. Buddhism emphasizes a feeling of pity (compassion). Islam pressures “insane” (being religious and pursuit of excellence).

Some times, religious set standards below the level of acceptable moral standards. Some religions do not give equal rights to women, as in Islam (particularly in Iran, Iraq). In this situation the conflict is not only between secular morality and religion but also among other religions.

By giving stress on the positive connections between secular morality and religion, we go for defining Divine Command ethics. It views that right action is defined by the commands of God, and without a belief in God there could be no moral values and if an action is said to be wrong, it means that it is forbidden by God.

The Major difficulties in Divine Command ethics are: how to know what God's commands are and whether God exists or not. Judaism, Christianity, Islam and Hinduism are mostly God-centered i.e., they believe in God. But some other religions such as Buddhism, Taoism and Confucianism calls for only faith in a right path from which code of ethics can be derived. For example in Buddhism the right path included eight steps such as ***right understanding, right intention, right intention, right action, right livelihood, right effort, right mindfulness and right concentration.***

Questions on the belief in God were rejected by most of he theologians, [Theology – study of God] based on the question asked by Socrates. Socrates asked why does god make certain commands and not others? Are these commands made on the basis of sudden fancy? The answer is surely no. Because God is supposed to be morally good and He never commands bad acts such as irresponsible killing, rapes, tortures and other immoralities.

Suppose a man claimed that God commands him to kill people randomly without making any religious inquiry, we can say that the main is mistaken.

Divine Command ethics has things backwards. A morally divine being commands on the basis of moral reasons which determines the wrongness of actions and rightness of other actions. Moral reasons are presupposed as the foundation for making certain commands. Moral reasons can not force hard to religious matters. Religious beliefs provides an added inspiration for responding to moral reasons.

USES OF ETHICAL THEORIES

Ethical theories have so many uses. Out of them, the following three are the most important uses:

1. Understanding moral dilemmas.
2. Justifying professional obligations and ideas and
3. Relating ordinary and professional morality

UNIT –II

ENGINEERING AS SOCIAL EXPERIMENTATION

Syllabus: Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study

ENGINEERING AS EXPERIMENTATION

Experimentation plays an important role in the process of designing the product. When it is decided to change a new engineering concept into its first rough design, preliminary tests or simulation should be conducted. Using formal experimental methods, the materials and methods of designing are tried out. These tests may be based on more detailed designs. The test for designing should be evolved till the final product produced. With the help of feedback of several tests, further modification can be made if necessary. Beyond these tests and experiments, each engineering project has to be viewed as an experiment.

Similarities to Standard Experiments

There are so many aspects, which are of virtual for combining every type of engineering works to make it suitable to look at engineering projects as experiments. The main three important aspects are:

1) Any engineering project or plan is put into practice with partial ignorance because while designing a model there are several uncertainities occurred. The reason to the fact that engineers don’t have all the needed facts available well in advance before starting the project. At some point, both the theoretical examining and the laboratory testing must be by-passed for the sake of completing the project. Really, the success of an engineer is based on the his talent which is exactly being the ability to succeed in achieving jobs with only a partial knowledge of scientific laws about the nature and society.

2) The final outcomes of engineering projects are generally uncertain like that of experiments what we do.

In engineering, in most of the cases, the possible outcomes may not be known and even small and mild projects itself involve greater risks.

The following uncertainities occur in the model designs

1. Model used for the design calculations

2. Exact characteristics of the material purchased.

3. Constancies of materials used for processing and fabrication.

4. About the nature of the pressure the finished product will encounter.

For instance, a reservoir may cause damage to the surroundings and affect the eco-system. If it leaks or breaks, the purpose will not be served. A special purpose fingerprint reader may find its application in the identification and close observation on the disagreeing persons with the government. A nuclear reactor may cause unexpected problems to the surrounding population leading to a great loss to the owners. A hair dryer may give damage to the unknowing or wrong users from asbestos insulation from its barrel.

3) Good and effective engineering depends upon the knowledge possessed about the products at the initial and end stages.

This knowledge is very useful for increasing the effectiveness of the current products as well as for producing better products in future. This can be achieved by keenly observing on the engineering jobs by the way of experimentation. This monitoring is done by making periodic observations and tests by looking at for the successful performance and the side effects of the jobs. The tests of the product's efficiency, safety, cost-effectiveness, environmental impact and its value that depends upon the utility to the society should also be monitored. It also extends to the stage of client use.

Learning from the past

It has been expected that the engineers have to learn not only form their own design and the production system but also the results of others. Due to lack of communication, prejudiced in not asking for clarification, fear of law and also mere negligence, these things can happen to the continuation of past mistakes. The following are some of the examples:

1. The tragedy of 'Titanic' happened because of the sufficient number of life boats. The same disaster took place in the steamship "the Arctic" some years before, because of the same problem.

2. The fall down of "the Sunshine Skyline Bridge" in the bay of Thamba at Sweden in 1980, on a moving ship due to improper matching of horizontal impact forces in mind. This could have been avoided of the engineers had known about the striking of the ships with the Maracaibo Bridge at Venezulea in 1964 and the Tasman Bridge of Australia in 1975.

3. The nuclear reactor accident at Three Mile Island on March 1979, was due to malfunctioning of the valves. Valves though minute items, are being among the least reliable components of hydraulic systems. It was a pressure relief valve and lack of information about its opening or closing state contributed to a nuclear reactor accident at Three Mile Island. This malfunction was already happened because of the same reasons at other locations.

4. The disaster of Tettron Dam in Los Angles was due to rapid flow of water and sudden break down. The builder didn't consider the case of the Fontenelle Dam, which was also collapsed due to the same problem.

So, to say that engineers should not fully depend on handbooks and they should have some review of the past cases relating to their current task.

Comparisons with standard Experiments

Engineering is entirely different from standard experiments in few aspects. Those differences are very much helpful to find out the special responsibilities of engineers and also help them in knowing about the moral irresponsibilities which are involved in engineering.

1. **Experimental Control**

Members for two groups should be selected in a standard experimental control, i.e Group A and Group B. The members of the group 'A' should be given the special experimental treatment. The group 'B' do not receive the same though they are in the same environment. This group is called the ***'control group'***

Though it is not possible in engineering but for the projects which are confirmed to laboratory experiments. Because, in engineering the experimental subjects are human beings who are out of the control of the experimenters. In engineering, the consumers have more control as they are the selecting authority of a project. So in engineering it is impossible to follow a random selection. An engineer has to work only with the past data available with various groups who use the products.

So engineering can be viewed as a natural experiment which uses human subjects. But today, most of the engineers do not care for the above said Experimental Control.

2. **Informed Consent**

Engineering is closely related to the medical testing of new drugs and techniques on human beings as it also concerned with human beings.

When new medicines have been tested, it should be informed to the persons who undergo the test. They have moral and legal rights to know about the fact which is based on **"informed consent"** before take part in the experiment. Engineering must also recognize these rights. When a producer sells a new product to a firm which has its own engineering staff, generally there will be an agreement regarding the risks and benefits form that testing.

Informed consent has two main principles such as knowledge and voluntariness.

First, the persons who are put under the experiment has to be given all the needed information to make an appropriate decision. Second, they must enter into the experiment without any force, fraud and deception. The experimenter has also to consider the fundamental rights of the minorities and the compensation for the harmful effects of that experiment.

In both medicine and engineering there may be a large gap between the experimenter and his knowledge on the difficulties of an experiment. This gap can be filled only when it is possible to give all the relevant information needed for drawing a responsible decision on whether to participate in the experiment or not.

In medicine, before prescribing a medicine to the patient, a responsible physician must search for relevant information on the side effects of the drug. The hospital management must allow him to undergo different treatments to different patients and finally the patient must be ready to receive that information from the physician. Similarly it is possible for an engineer to give relevant information about a product only when there is a better co-operation by the management and quick acceptance from the customers.

The following conditions are essential for a valid informed consent

a. The consent must be given voluntarily and not by any force.

b. The consent must be based on the relevant information needed by a rational person and should be presented in a clear and easily understandable form.

c. The consenter must be capable of processing the information and to make rational decisions in a quick manner.

d. The information needed by a rational person must be stated in a form to understand without any difficulty and has to be spread widely.

e. The experimenter's consent has to be offered in absentia of the experimenter by a group which represents many experiments.

Knowledge Gained

Scientific experiments have been conducted to acquire new knowledge. Whereas engineering projects are conducted as experiments not for getting new knowledge. Suppose the outcomes of the experiment is best, it tells us nothing new, but merely affirms that we are right about something. Mean while, the unexpected outcomes put us search for new knowledge.

ENGINEERS AS RESPONSIBLE EXPERIMENTERS

The engineers have so many responsibilities for serving the society.

1. A primary duty is to protect the safety of human beings and respect their right of consent. [A conscientious commitment to live by moral values].
2. Having a clear awareness of the experimental nature of any project, thoughtful forecasting of its possible side effects, and an effort to monitor them reasonably. [A comprehensive perspective or relative information].
3. Unrestricted free personal involvement in all the steps of a project. [Autonomy]
4. Being accountable for the results of a project [Accountability]
5. Exhibiting their technical competence and other characteristics of professionalism.

Conscientiousness

Conscientiousness implies consciousness (sense of awareness). As holding the responsible profession with maintaining full range moral ethics and values which are relevant to the situation. In order to understand the given situation, its implications, know-how, person who is involved or affected, Engineers should have open eyes, open ears and open mind.

The present working environment of engineers, narrow down their moral vision fully with the obligations accompanied with the status of the employee. More number of engineers are only salaried employees, so, they have to work within large bureaucracies under great pressure to work smoothly within the company. They have to give importance only to the obligations of their employers. Gradually, the small negative duties such as not altering data by fraud, not violating patent right and not breaking confidentiality, may be viewed as the full extent of moral desire.

As mentioned, engineering as social experimentation brings into light not only to the person concerned but also to the public engineers as guardians of the public interest i.e., to safeguard the welfare and safety of those affected by the engineering projects. This view helps to ensure that this safety and welfare will not be affected by the search for new knowledge, the hurry to get profits, a small and narrow follow up of rules or a concern over benefits for the many and ignoring the harm to the few.

The social experimentation that involved in engineering should be restricted by the participants consent.

Relevant Information

Without relevant factual information, conscientious is not possible. For showing moral concern there should be an obligation to obtain and assess properly all the available information related to the fulfillment of one's moral obligations. This can be explained as:

1) To understand and grasp the circumstance of a person's work, it is necessary to know about how that work has a moral importance. For example, A person is trying to design a good heat exchanger. There is nothing wrong in that. But at the same time, if he forgets the fact that the heat exchanger will be used in the manufacture of an illegal product, then he is said to be showing a lack of moral concern. So a person must be aware of the wider implication of his work that makes participation in a project.
2) Blurring the circumstance of a person's work derived from his specialization and division of labour is to put the responsibilities on someone else in the organization. For example if a company produces items which are out of fashion or the items which promotes unnecessary energy wastage, then it is easy to blame sales department.

The above said means, neglecting the importance of a person's works also makes it difficult in acquiring a full perspective along a second feature of factual information i.e., consequence of what one does.

So, while giving regard to engineering as social experimentation, points out the importance of circumstances of a work and also encourage the engineers to view his specialized activities in a project as a part of a large social impact.

Moral Autonomy

This refers to the personal involvement in one's activities. People are morally autonomous only when their moral conduct and principles of actions are their own i.e., genuine in one's commitment to moral values.

Moral beliefs and attitudes must be integrated into an individual's personality which leads to a committed action. They cannot be agreed formally and adhered to merely verbally. So, the individual principles are not passively absorbed from others. When he is morally autonomous and also his actions are not separated from himself.

When engineering have seen as a social experimentation, it helps to keep a sense of autonomous participation in a person's work. An engineer, as an experimenter, is undergoing training which helps to form his identity as a professional. It also results in unexpected consequence which helps to inspire a critical and questioning attitudes about the current economic and safety standards. This also motivates a greater sense of personal involvement in a person's work.

Accountability

The people those who feel their responsibility, always accept moral responsibilities for their actions. It is known as accountable. In short, 'accountable' means being culpable and hold responsible for faults. In general and to be proper, it means the general tendency of being willing to consider one's actions to moral examinations and be open and respond to the assessment of others. It comprises a desire to present morally convincing reasons for one's conduct when called upon in specific circumstances.

The separation of causal influence and moral accountability is more common in all business and professions and also in engineering. These differences arising from several features of modern engineering practices are as follows:

1. Large – scale engineering projects always involve division of work. For each and every piece of work, every person contributes a small portion of their work towards the completion of the project. The final output us transmitted from one's immediate work place to another causing a decrease in personal accountability.
2. Due to the fragmentation of work, the accountability will spread widely within an organization. The personal accountability will spread over on the basis of hierarchies of authority.
3. There is always a pressure to move on to a different project before finishing the current one. This always leads to a sense of being accountable only for fulfilling the schedules.
4. There is always a weaker pre-occupation with legalities. In other words this refers to a way a moral involvement beyond the laid down institutional role. To conclude, engineers are being always blamed for all the harmful side effects of their projects. Engineers cannot separate themselves from personal responsibilities for their work.

CODES OF ETHICS

The codes of ethics have to be adopted by engineering societies as well as by engineers. These codes exhibit the rights, duties, and obligations of the members of a profession. Codes are the set of laws and standards.

A code of ethics provides a framework for ethical judgment for a professional. A code cannot be said as totally comprehensive and cover all ethical situations that an engineer has to face. It serves only as a starting point for ethical decision-making. A code expresses the circumstances to ethical conduct shared by the members of a profession. It is also to be noted that ethical codes do not establish the new ethical principles. They repeat only the principles and standards that are already accepted as responsible engineering practice. A code defines the roles and responsibilities of professionals.

Roles of codes and its functions

1. **Inspiration and Guidance**

Codes give a convinced motivation for ethical conduct and provide a helpful guidance for achieving the obligations of engineers in their work. Codes contribute mostly general guidance as they have to be brief. Specific directions may also be given to apply the code in morally good ways. The following engineering societies have published codes of ethics.

AAES - American Association of Engineering Societies

ABET - Accreditation Board for Engineering and Technology (USA)

NSPE - National Society of Professional Engineer (USA)

IEEE - Institute of Electrical and Electronics Engineering (USA)

AICTE - All India Council for Technical Education (India)

Most of the technological companies have established their own codes such as pentagon (USA), Microsoft etc. These codes are very much helpful to strengthen the moral issues on the work of an engineer.

2. **Support**
   Codes always support an engineer who follows the ethical principles. Codes give engineers a positive, a possible good support for standing on moral issues. Codes also serve as a legal support for engineers.
3. **Deterrence and Discipline**
   Codes act as a deterrent because they never encourage to act immorally. They also provide discipline among the Engineers to act morally on the basis of codes does not overrule the rights of those being investigated.
4. **Education and Mutual Understanding**
   Codes have to be circulated and approved officially by the professionals, the public and government organizations which concern with the moral responsibilities of engineers and organizations.
5. **Contributing to the profession’s Public Image**
   Codes help to create a good image to the public of an ethically committed

profession. It helps the engineers in an effective manner to serve the public. They also gives self-regulation for the profession itself.

6. **Protecting the Status Quo**

   Codes determine ethical conventions which help to create an agreed upon minimum level of ethical conduct. But they can also suppress the disagreement within the profession.

7. **Promoting Business Interests**

   Codes help to improve the business interests. They help to moralize the business dealings to benefit those within the profession.

Limitations of Codes

1. Codes are restricted to general and vague wordings. Due to this limitation they cannot be applicable to all situations directly. It is also impossible to analyze fully and predict the full range of moral problems that arises in a complex profession.
2. Engineering codes often have internal conflicts. So they can't give a solution or method for resolving the conflict.
3. They cannot be treated as the final moral authority for any professional conduct. Codes represent a compromise between differing judgments and also developed among heated committee disagreements.
4. Only a few practicing engineers are the members of Professional Societies and so they can not be compelled to abide by their codes.
5. Many engineers who are the members of Professional Societies are not aware of the existence of the codes of their societies and they never go through it.
6. Codes can be reproduced in a very rapid manner.
7. Codes are said to be coercive i.e., implemented by threat or force.

A BALANCED OUTLOOK ON LAW

A balanced outlook on laws stresses the necessity of laws and regulations and their limitations in directing engineering practice.

In order to live, work and play together in harmony as a society, there must be a balance between individual needs and desires against collective needs and desires. Only ethical conduct can provide such a balance. This ethical conduct can be applied only with the help of laws. Laws are important as the people are not fully responsible and because of the competitive nature of the free enterprise system which does not encourage moral initiative.

The model of engineering as social experimentation allows for the importance of clear laws to be effectively enforced.

Engineers ought to play an effective role in promoting or changing enforceable rules of engineering as well as in enforcing them. So the codes must be enforced with the help of laws. The following are the two best examples.

1. **Babylon's Building Code: (1758 B.C.)**

   This code was made by Hammurabi, king of Babylon. He formed a code for builders of his time and all the builders were forced to follow the code by law. He ordered

   "If a builder has built a house for a man and has not made his work sound, and the house which he has built was fallen down and so caused the death of the householder, that builder shall be put to death. If it causes the death of the house holder's son, they shall put that builder's son to death. If it causes the death of the house holder's slave, he shall give slave to the householder. If it destroys property he shall replace anything it has destroyed; and because he has not made the house sound which he has built and it has fallen down, he shall rebuild the house which has fallen down from his own property. 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 in to sound condition at his own cost".

   The above portion of Babylon's building code was respected duly. But the aspects find only little approval today. This code gives a powerful incentive for self-regulation.

2. **The United States Steamboat Code: [1852 A.D]**

   Steam engines in the past were very large and heavy. James Watt, Oliver Evans and Richard Trevethik modified the old steam engines by removing condensers and made them compact. Beyond careful calculations and guidelines, explosions of boiler happened on steam boats, because of the high speed of the boats. The safety valves were unable to keep steam pressure up causing explosion. During that period in 18^{th} century, more than 2500 people were killed and 2000 people were injured because of the explosion of boilers in steam boats.

   Due to this, the ruling congress in USA passed a law which provided for inspection of the safety aspects of ships and their boilers and engines. But his law turned out to be ineffective due to the corruptions of the inspectors and also their inadequate training regarding the safety checking. Then Alfred Guthiro, an engineer of Illinoise had inspected about 200 steam boats on his own cost and found out the reasons for the boiler explosions and made a report. His recommendations were published by a Senator Shields of Illinoise and incorporated in senate documents. With the help of this, another law was passed. Now it is in the hands of the American Society of Mechanical Engineers who formulated the standards for producing steam boats.

THE CHALLENGER CASE STUDY

The world has known about many number of accidents. Among them the explosion of the space shuttle 'Challenger' is the very familiar one. In those days 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. What is the exact role of the engineer when safety issues are concern? Who should have the ultimate authority for decision making to order for a launch? Whether the ordering of a launch be an engineering or a managerial decision?

Challenger space shuttle was designed to be a reusable one. The shuttle mainly consisted of an orbiter, two solid propellant boosters and a single liquid-propeller booster. All the boosters was ignited and the orbiter was lifted out the earth. The solid rocket booster was of reusable type. The liquid propellant booster was used to finish the lifting of the shuttle in to the orbit. This was only a part of the shuttle which has been reused.

The accident took place on 28 th 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 made up of synthetic rubber only, not specifically hat resistant. The function of the O-rings are to prevent the combustion gases of the solid propellant from escaping. The O-rings were eroded by hot gases, 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 in a controlled mannaer, and they would not completely burnt through, then the design of the joint would be acceptable, however the design of the O-rings in this shuttle was not so.

In the post flight experiment in 1985, the Thiokol engineers noticed black soot and grease on the outside of the boosters due to leak 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.

Before launching, it was necessary to discuss the political environment under which NASA was operating at that time. Because the budget of NASA has decided by Congress. These factors played the main cause for unavoidable delay in the decision to be taken for the shuttle performance, the pressures placed for urgency in launching in 1986 itself, before the launch of RUSSIAN probe to prove to the congress that the program was on processing. The launching date had already been postponed for the availability of vice president GEORGE BUSH, the space NASA supporter. Later further 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 tele-conferences further delayed the previous testing in 1985 itself. The lowest temperature was 53°F but O-ring temperature during the proposed launch period happened to be only 29 F$^{\circ}$, which was far below the environment temperature at which NASA had the previous trail. Somehow, the major factor that made the revised final decision was that previous trial. Somehow, the major factor that made the revised final decision was that with the available data at that time there seemed to be 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.

But unexpectedly the overnight temperature at the time of launch was 8 F$^{\circ}$ colder than ever experienced. It was estimated that the temperature of the right hand booster would be only at 28 $^{\circ}$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.

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 Rogers Commission which constituted 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.

As the result of commission hearings, a lot of controversial arguments went on among the Thiokol engineers. Thiokol and NASA investigated possible causes of the explosion. Mr.Boisjoly, the main member in the investigation team, accused Thiokol and NASA of intentionally downplaying the problems with the O-rings while looking for the other causes of the accidents. The hot discussions hurted the feelings and status of the headed engineers like Mr.Boisjoly, Mr.Curtis and Mr.Mellicam. Finally the management's atmosphere also became intolerable. This event shows the responsibility, functions, morality, duties of the engineers leading to ethical problems.

UNIT –III

ENGINEER’S RESPONSIBILITY FOR SAFETY

Syllabus: Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and chernobyl case studies.

SAFETY AND RISK

Risk is akey element in any engineering design.

Concept of Safety:

A thing is safe if its risks are judged to be acceptable. Safety are tactily value judgments about what is acceptable risk to a given person or group.

Types of Risks:

Voluntary and Involuntary Risks

Short term and Long Term Consequences

Expected Portability

Reversible Effects

Threshold levels for Risk

Delayed and Immediate Risk

Risk is one of the most elaborate and extensive studies. The site is visited and exhaustive discussions with site personnel are undertaken. The study usually covers risk identification, risk analysis, risk assessment, risk rating, suggestions on risk control and risk mitigation.

Interestingly, risk analysiscan beexpanded to fullfledgerisk managementstudy. The risk management study also includes residual risk transfer, risk financing etc. ***Stepwise, Risk Analysis will include:***

- Hazards identification
- Failure modes and frequencies evaluation from established sources and best practices.
- Selection of crediblescenarios and risks.
- Fault and event trees for various scenarios.
- Consequences-effect calculations with work out from models.
- Individual and societal risks.
- ISO risk contours superimposed on layouts for various scenarios.
- Probability and frequency analysis.
- Established risk criteria of countries, bodies, standards.
- Comparison of risk against defined risk criteria.
- Identification of risk beyond the location boundary, if any.
- Risk mitigation measures.

The steps followed are need based andall or some of these may be required from the above depending upon the nature of site/plant.

Risk Analysis is undertaken after detailed site study and will reflect Chilworth exposureto varioussituations. Itmay also includestudy on frequency analysis, consequences analysis, risk acceptability analysis etc., if required. Probability and frequency analysis covers failure modes and frequencies from established sources and best practices for various scenarios and probability estimation.

Consequences analysis deals with selection of credible scenarios and consequences effect calculation including worked out scenarios and using software package.

RISK BENEFIT ANALYSIS AND REDUCING RISK

Risk-benefit analysisis the comparison of theriskof a situation to its related benefits.

For research that involves more than minimal risk of harm to the subjects, the investigator must assure that the amount of benefit clearly outweighs the amount of risk. Only if there is favorable risk benefit ratio, a study may be considered ethical.

Risk Benefit Analysis Example

Exposure to personal risk is recognized as a normal aspect of everyday life. We accept a certain level of risk in our lives as necessary to achieve certain benefits. In most of these risks we feel as though we have some sort of control over the situation. For example, driving an automobile is a risk most people take daily. "The controlling factor appears to be their perception of their individual ability to manage the risk-creating situation." Analyzing therisk ofasituation is, however, very dependenton theindividualdoing theanalysis. When individuals are exposed to involuntary risk, risk which they have no control, they make risk aversion their primary goal. Under these circumstances individuals require the probabilty of risk to be as much as one thousand times smaller then for the same situation under their perceived control.

Evaluations of future risk:

- Real future risk as disclosed by the fully matured future circumstances when they develop.
- Statistical risk, as determined by currently available data, as measured actuarially for insurance premiums.
- Projected risk, as analytically based on system models structured from historical studies.
- Perceived risk, as intuitively seen by individuals.

Air transportation as an example:

- Flight insurance company -statistical risk.
- Passenger -percieved risk.
- Federal Aviation Administration(FAA) -projected risks.

How to Reduce Risk?

1.Define the Problem

2.Generate Several Solutions

3. Analyse each solution to determine the pros and cons ofeach

4. Test the solutions

5.Select the best solution

6. Implement the chosen solution

7. Analyse the risk in the chosen solution

8. Try to solve it. Or move to next solution.

Risk-Benefit Analysis and Risk Management

Informative risk-benefit analysis and effectiverisk managementare essential to the ultimate commercial success of your product. We are a leader in developing statistically rigorous, scientifically valid risk-benefit assessment studies that can be used to demonstrate the level of risk patients and other decision makers are willing to accept to achieve the benefits provided by your product.

Risk-Benefit Modeling	Systematically quantify the relative importance of risks and benefits to demonstrate the net benefits of treatment
Risk-Benefit Tradeoffs	Quantify patients' maximum acceptable risk for specific therapeutic benefits

CHERNOBYL CASE STUDIES

What Happened?

At 1:24 AM on April 26, 1986, there was an explosion at the Soviet nuclear power plant at Chernobyl. Oneof thereactorsoverheated, igniting apocket ofhydrogen gas. Theexplosion blew the top off the containment building, and exposed the molten reactor to the air. Thirty-one power plant workers were killed in the initial explosion, and radioactive dust and debris spewed into the air.

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Ittook severaldaysto putoutthefire. Helicoptersdropped sand and chemicalson thereactor rubble, finally extinguishing the blaze. Then the Soviets hastily buried the reactor in a sarcophagus of concrete. Estimates of deaths among the clean-up workers vary widely. Four thousand clean-up workers may have died in the following weeks from the radiation.

The countries now known as Belarus and Ukraine were hit the hardest by the radioactive fallout. Winds quickly blew the toxic cloud from Eastern Europe into Sweden and Norway. Within a week, radioactive levels had jumped over all of Europe, Asia, and Canada. It is estimated thatseventy-thousand Ukrainianshavebeen disabled, and fivemillion peoplewere exposed to radiation. Estimates of total deaths due to radioactive contamination range from 15,000 to 45,000 or more.

To give you an idea of the amount of radioactive material that escaped, the atomic bomb dropped on Hiroshima had a radioactive mass of four and a half tons. The exposed radioactive mass at Chernobyl was fifty tons.

In themonthsand yearsfollowing, birth defectswerecommon for animalsand humans. Even the leaves on the trees became deformed.

Today, in Belarusand Ukraine, thyroid cancer and leukemiaarestillhigher than normal. The towns of Pripyat and Chernobyl in the Ukraine are ghost towns. They will be uninhabitable due to radioactive contamination for several hundred years. The worst of the contaminated area is called “The Zone,” and it is fenced off. Plants, meat, milk, and water in the area are stillunsafe. Despitethecontamination, millionsofpeoplelivein and near TheZone, too poor to move to safer surroundings.

Further, human genetic mutations created by the radiation exposure have been found in children who have only recently been born. This suggests that there may be another whole generation of Chernobyl victims.

Recentreportssay thattherearesomeindicationsthattheconcretesarcophagusatChernobyl is breaking down.

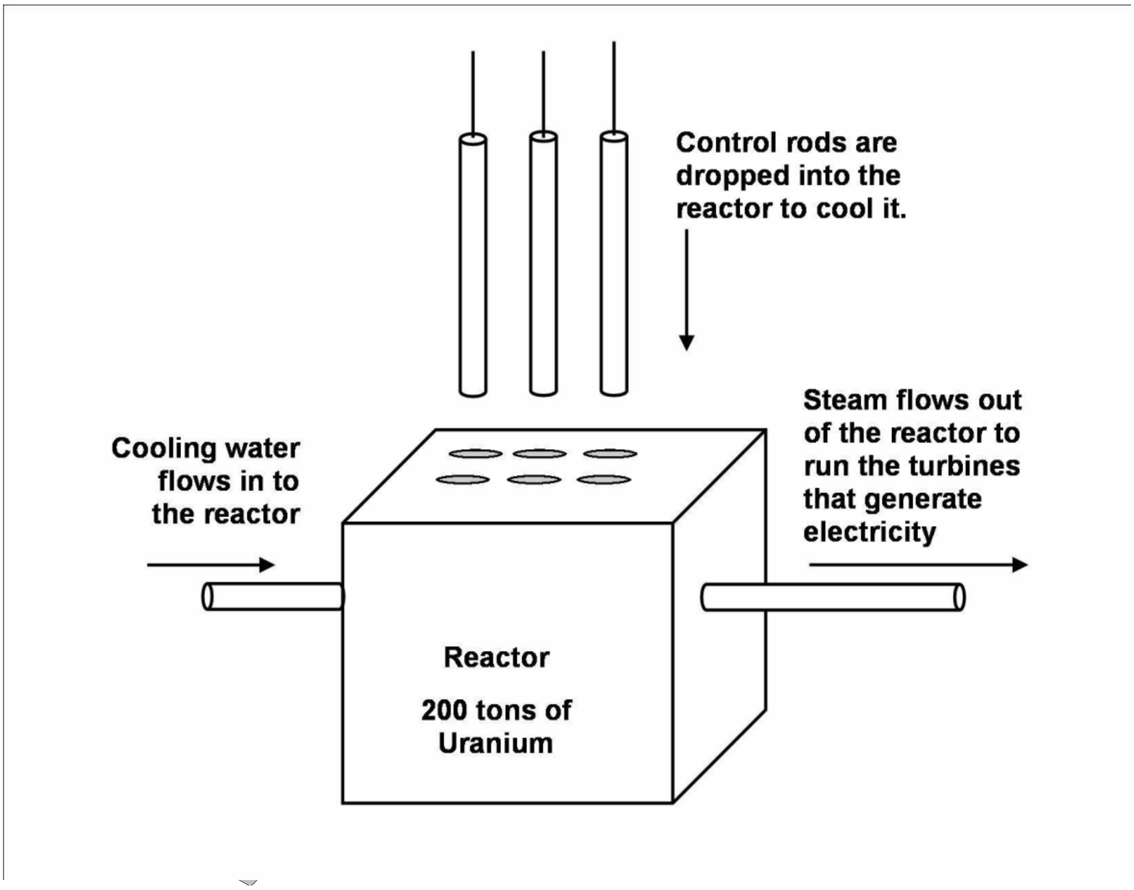
How a Nuclear Power Plant Works

The reactor at Chernobyl was composed of almost 200 tons of uranium. This giant block of uranium generated heat and radiation. Water ran through the hot reactor, turning to steam. The steam ran the turbines, thereby generating electricity. The hotter the reactor, the more electricity would be generated.

Leftto itself, the reactor would become too *reactive*—it would become hotter and hotter and more and more radioactive. If the reactor had nothing to cool it down, it would quickly *meltdown*Ña process where the reactor gets so hot that it meltsÑmelting through the floor. So, engineers needed a way to control the temperature of the reactor, to keep it from the catastrophic meltdown. Further, the engineers needed to be able to regulate the temperature of the reactor—so that it ran hotter when more electricity was needed, and could run colder when less electricity was desired.

The method they used to regulate the temperature of the reactor was to insert heat-absorbing rods, called *control rods*. These control rods absorb heat and radiation. The rods hang above the reactor, and can be lowered into the reactor, which will cool the reactor. When more electricity is needed, the rods can be removed from the reactor, which will allow the reactor to heat up. The reactor has hollow tubes, and the control rods are lowered into these reactor tubes, or raised up out of the reactor tubes. At the Chernobyl-type reactors, there are 211 control rods. The more control rods that are inserted, the colder the reactor runs. The more control rods that are removed, the hotter the reactor becomes.

How a Nuclear Power Plant Works



Soviet safety procedures demanded that at least 28 rods were inserted into the Chernobyl reactor at all times. This was a way to make sure that the reactor wouldn't overheat.

Water was another method to moderate the temperature of the reactor. When more water ran through the reactor, the reactor cooled faster. When less water ran through the reactor, the reactor stayed hot.

Chernobyl Background

The list of senior engineers at Chernobyl was as follows: Viktor Bryukhanov, the plant director, was a pure physicist, with no nuclear experience.

Anatoly Dyatlov, the deputy chief engineer, served as the day-to-day supervisor. He had worked with reactor cores but had never before worked in a nuclear power plant. When he accepted the job as deputy chief engineer, he exclaimed, "you don't have to be a genius to figure out a nuclear reactor."

Theengineers were Aleksandr Akimov, serving his first position in this role; NikolaiFomin, an electrical engineer with little nuclear experience; Gennady Metlenko, an electrical engineer; and Leonid Toptunov, a 26 year-old reactor control engineer. The engineers were heavy in their experience of electric technology, but had less experience with the uniqueness of neutron physics.

The confidence of these engineers was exaggerated. They believed they had decades of problem-freenuclear work, so they believed thatnuclear power wasvery safe. Theengineers believed that they could figure out any problem. In reality, there had been many problems in the Soviet nuclear power industry. The Soviet state tried to keep problems a secret because problems are bad PR.

TheSovietshad anumber ofnuclear accidents(thisisapartiallistofSovietaccidentsbefore Chernobyl). In 1957 in Chelyabinsk, therewasasubstantialreleaseofradioactivity caused by a spontaneous reaction in spent fuel; in 1966 in Melekess the nuclear power plant experienced a spontaneous surge in power, releasing radiation; In 1974, there was an explosion at the nuclear power plant in Leningrad; Later in 1974, at the same nuclear power plant, threepeoplewerekilled and radiation wasreleased into theenvironment;in1977, there wasapartialmeltdown ofnuclear fuelatByeloyarsk;in 1978 atByeloyarsk, thereactor went out of control after a roof panel fell onto it; In 1982 at Chernobyl, radioactivity was released into the environment; In 1982, there was there was a fire at Armyanskaya; In 1985, fourteen people were killed when a relief valve burst in Balakovo.

Had the engineers at Chernobyl had the information of the previous nuclear accidents, perhaps they would have known to be more careful. It is often from mistakes that we learn, and the engineers at Chernobyl had no opportunity to learn.

As a footnote, don't think that the problems were just those mistake-laden Soviets. Here is a partial list of American accidents before Chernobyl: In 1951, the Detroit reactor overheated, and air was contaminated with radioactive gasses; In 1959, there was a partial meltdown in Santa Susanna, California; In 1961, three people were killed in an explosion at the nuclear power plant at Idaho Falls, Idaho; In 1966, there was a partial meltdown at a reactor near Detroit;In 1971, 53,000 gallonsofradioactivewater werereleased into theMississippiRiver from the Monticello plant in Minnesota; In 1979, there was population evacuation and a discharge of radioactive gas and water in a partial meltdown at Three Mile Island; in 1979 there was a discharge of radiation in Irving Tennessee; In 1982, there was a release of radioactive gas into the environment in Rochester, New York; In 1982, there was a leak of radioactive gasses into the atmosphere at Ontario, New York; In 1985, there was a leak of radioactive water near New York City; In 1986, one person was killed in an explosion of a tank of radioactive gas in Webbers Falls, Oklahoma.

The engineers at Chernobyl didn’t know about these nuclear accidents. These were secrets thattheSovietskeptfromthenuclear engineers. Consequently, no onewasableto learn from the mistakes of the past. The nuclear plant staff believed that their experience with nuclear power was pretty much error-free, so they developed an overconfidence about their working style.

So, according to Gregori Medvedev (the Soviet investigator of Chernobyl), their practice becamelazy and their safety practicesslipshod. Further, theheavy bureaucracy and hierarchy of the Soviet system created an atmosphere where every decision had to be approved at a variety of higher levels. Consequently, the hierarchical system had quelled the operators' creativity and motivation for problem-solving.

April 25th, 1:00 PM

The engineers at Chernobyl had volunteered to do a safety test proposed by the Soviet government. In theeventofareactor shutdown, aback-up systemofdieselgeneratorswould crank up, taking over the electricity generation. However, the diesel engines took a few minutes to start producing electricity. The reactor had a turbine that was meant to generate electricity for a minute or two until the diesel generators would start operating. The experiment at Chernobyl was meant to see exactly how long that turbine would generate the electricity.

The experiment required that the reactor be operating at 50% of capacity. On April 25th, 1986, at 1:00 PM, the engineers began to reduce the operating power of the reactor, by inserting the control rods into the reactor. This had the effect, you may recall, of cooling off the reactor—making it less reactive.

They also shutdown theemergency cooling system. They wereafraid thatthecooling system might kick in during the test, thereby interfering with the experiment. They had no authorization to deactivate the cooling system, but they went ahead and deactivated it.

The experiment called for running the reactor at 50% capacity, thereby generating only half the electricity. At 2:00 PM, a dispatcher at Kiev called and asked them to delay the test because of the higher-than-expected energy usage. They delayed the test, but did not reactivate the emergency cooling system.

April 25th, 11:00 PM

At11:00 PM, they began thetestagain. Toptunov, thesenior reactor controlengineer, began to manually lower the reactor to 50% of its capacity so that they could begin the turbine safety experiment.

Lowering the power generation of a nuclear reactor is a tricky thing. It is not like lowering thethermostatin ahouse. When you lower thethermostatinthehousefrom72 to 68 degrees, the temperature in the house will drop to 68 degrees and stay there. But in a nuclear reactor, thedropping ofthetemperatureisnotonly the*result*oflowering thereactivity, butitisalso a *cause* of lowering the reactivity. In other words, the coldness of the reactor will make the reactor colder. This is called the *self-damping effect*. Conversely, when the reactor heats up, the heat of the reactor will make itself hotter (the self-amplifying effect).

So, when the control rods are dropped into the reactor, the reactivity goes down. And the water running through the reactor also lessens reactivity. But the lower reactivity also makes thereactor itselflessreactive. So, theChernobylreactor damped itself, even asthewater and the control rods damped its reactivity.

It is typically hard for people to think in terms of exponential reduction or exponential increase. Wenaturally think ofalinear (straight-line) reduction or alinear increase. Wehave trouble with self-damping and self-amplifying effects, because they are nonlinear by definition.

So, theengineersoversteered theprocess, and hitthe50% mark, butthey wereunableto keep it there. By 12:30 AM, the power generation had dropped to 1% of capacity.

Chernobyl-type reactors are not meant to drop that low in their capacity. There are two problemswith thenuclear reactor running at1% ofcapacity. When reactivity dropsthatlow, the reactor runs unevenly and unstably, like a bad diesel engine. Small pockets of reactivity can begin thatcan spread hotreactivity through thereactor. Secondly, thelowrunning ofthe reactor creates unwanted gasses and byproducts (xenon and iodine) that poison the reactor. Because of this, they were strictly forbidden to run the reactor below 20% of capacity.

In the Chernobyl control room, Dyatlov (the chief engineer in charge of the experiment), upon hearing thereactor wasat1%, flewinto arage. With thereactor capacity wasso low, he would notbeableto conducthissafety experiment. With thereactor at1% capacity, Dyatlov had two options:

1. One option was to let the reactor go cold, which would have ended the experiment, and then they would have to wait for two days for the poisonous byproducts to dissipate before starting the reactor again. With this option, Dyatlov would no doubt have been reprimanded, and possibly lost his job.
2. The other option was to immediately increase the power. Safety rules prohibited increasing the power if the reactor had fallen from 80% capacity. In this case, the power had fallen from 50% capacity—so they were not technically governed by the safety protocols.

Dyatlov ordered the engineers to raise power.

Today, we know the horrible outcome of this Chernobyl chronology. It is easy for us to sit back in our armchairs, with the added benefit of hindsight, and say Dyatlov made the wrong choice. Of course, he could have followed the spirit of the protocols and shut the reactor down. However, Dyatlov did nothavethebenefitofhindsight. Hewasfaced with thechoice ofthe*surety*ofreprimand and theharming ofhiscareer vs. the*possibility*ofsafety problems. And, we know from engineers and technical operators everywhere, safety protocols are *routinely* breached when faced with this kind of choice. Experts tend to believe that they are experts, and that the safety rules are for amateurs.

Further, safety rules are not designed so that people are killed instantly when the safety standard isbroken. On a55-mileper hour limiton ahighway, carsdo notsuddenly burstinto flames at 56 miles per hour. In fact, there is an advantage to going 56 miles an hour as opposed to 55 (you get to your destination faster). In the same way, engineers frequently view safety rules as troublesome, and there is an advantage to have the freedom to disregard them.

In fact, we experience this psychologic every day, usually without thinking about it. When you come toward an intersection, and the light turns yellow, you reach a point where you either haveto go through on ayellowlight, or cometo astop. Many peoplego through on the yellow, even though thereisagreater risk. So, in asplitsecond, wedecidebetween thesurety of sitting at a red light or the possibility, albeit slight, of a safety problem to go through the yellowlight. Thereisaclear advantageto taketherisk (aslong asyou aren'tin an accident). While the stakes were higher at Chernobyl, the same psychologic applies.

At this point in the Chernobyl process, there were 28 control rods in the reactor—the minimumrequired. Increasing power would mean thateven morecontrolrodswould haveto be removed from the reactor. This would be a breach of protocol--the minimum number of rods was 28. Dyatlov gave the order to remove more control rods.

Toptunov, the reactor control engineer, refused to remove any more rods. He believed it would be unsafe to increase the power. With the reactor operating at 1%, and the minimum number of control rods in the reactor, he believed it would be unsafe to remove more rods. He was abiding by a strict interpretation of the safety protocols of 28 rods.

But Dyatlov continued to rage, swearing at the engineers and demanding they increase power. Dyatlov threatened to fire Toptunov immediately if he didn't increase the power.

The 26-year-old Toptunov was faced with a choice. He believed he had two options:

1. He could refuse to increase power—but then Dyatlov would fire him immediately, and his career would be over.
2. His other choice was to increase power, recognizing that something bad *might* happen.

Toptunov looked around. Alltheother engineers—including hissupervisors—werewilling to increase power. Toptunov knew he was young and didn't have much experience with reactors. Perhaps this kind of protocol breach was normal. Toptunov was faced with that choice of the *surety* of his career ending, vs the *possibility* of safety problems. Toptunov decided to agree and increase the power.

Tragically, it would be the last decision Toptunov would ever make.

April 26th, 1:00 AM

By 1:00 AM, the power of the reactor was stable at 7% of capacity. Only 18 control rods were in the reactor (safety protocols demanded that no less than 28 control rods should always be in the reactor).

At1:07 AM, theengineerswanted to makesurethereactor wouldn'toverheat, so they turned on more water to ensure proper cooling (they were now pumping five times the normal rate of water through the reactor). The extra water cooled the reactor, and the power dropped again. Theengineersresponded by withdrawing even morecontrolrods. Now, only 3 control rods were inserted in the reactor.

The reactor stabilized again. The engineers, satisfied with the amount of steam they were getting (they needed steamfor their experiment) shutoffthepumpsfor theextrawater. They shut off the water, apparently only considering the effect that the water would have on the experiment—and did notconsider theeffectthatthewater washaving on thereactor. Atthis point, with only 3 control rods in the reactor, the water was only thing keeping the reactor cool. Without the extra cool water, the reactor began to get hot. Power increased slowly at first. As the reactor got hotter, the reactor itself made the reactor hotter—the self-amplifying effect. The heat and reactivity of the reactor increased exponentially.

The engineers were trying to watch multiple variables simultaneously. The water, the steam, the control rods, and the current temperature of the reactor all were intertwined to affect the reactivity of the reactor. People can easily think in cause and effect terms. Had their only been one variable that controlled the reactivity, the results would probably have been different. However, people have difficulty thinking through the process when there are a multitude of variables, all interacting in different ways.

Peoplearenotprocessorsofunlimited information. Thereisalimited amountofinformation with which a person can work. With the safety of hindsight, we can sit back and make a judgment saying, "they didn't think through all their information." However, this kind of linear judgment does not tell us*why*they didn't see what is obvious to our hindsight.

At1:22 AM(90 secondsbeforetheexplosion), theengineerswerestillrelaxed and confident. Dyatlov, in fact, wasseeing histurbinesafety experimentcoming to asuccessfulconclusion. In whatturned outto beatragicirony, heencouraged hisengineersby suggesting, “in two or three minutes it will all be over.”

Thirty seconds before the explosion, the engineers realized the reactor was heating up too fast. With only 3 control rods in the reactor, and then shutting off the water, the reactor was superheating. In a panic, they desperately tried to drop control rods into the reactor, but the heat of the reactor had already melted the tubes into which the control rods slid.

Thefloor ofthebuilding began to shake, and loud banging started to echo through thecontrol room. Thecoolantwater began to boilviolently, causing thepipesto burst. Thesuper-heating reactor was creating hydrogen and oxygen gasses. This explosive mixture of gasses accumulated abovethereactor. Theheatofthereactor wasbuilding fast, and thetemperature of the flammable gasses was rising.

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April26th, 1:24 AM

Finally, the gasses detonated, destroying the reactor and the protectivecontainmentbuilding. The control room was far enough away from the containment building to escape destruction, but the explosion shook the entire plant. Debris caved in around the control room members, and Dyatlov, Akimov, Toptunov, and the others were knocked to the floor. Dust and chalk filled the air. While they knew there had been an explosion, they hoped and prayed the explosion had not come from the reactor. Toptunov and Akimov ran over the broken glass and ceiling debris to the open door, and ran across the compound toward the containment building. There, they saw the horrifying, unspeakable sight. There was rubble where the reactor had been. They sawflamesshooting up 40 feethigh, burning oilsquirting frompipes onto theground, black ash falling to theground, and abrightpurplelightemanating fromthe rubble.

Within a few minutes, fire fighters had arrived. The fire fighters, most with no protective equipment, heroically worked to extinguish the fire, hoping to prevent further damage to the three other reactors at the plant. Most of the fire fighters died from the radiation exposure.

Bryukhanov (theplantdirector), who wasnotattheplantatthetime, had been contacted and told about an explosion. In the chaos, those informing Bryukhanov of the explosion still did not know the total amount of devastation. Bryukhavov, still desperately hoping that the reactor wasintact, called Moscowto informthemthatwhiletherehad been an explosion, the reactor had not sustained any damage.

Again, with thebenefit of hindsight, we can say that Bryukhanov should have acted quicker. It's true that many lives could have been saved if he had acted differently. However, his actions are not uncommon in these kinds of situations. A common reaction is called "horizontalflight,"wherepeopleretreatfromtheworst-casescenario, convincing themselves to believethebest-casescenario. Bryukhanov had convinced himselfthatthereactor wasnot in danger. And after all, someonefromtheplanthad called and given an ambiguousmessage. Surely they would have known if the reactor had been destroyed.

April 26th, 4:00 AM

At 4:00 AM, the command from Moscow came back: *Keep the reactor cool*. The authorities in Moscow had no idea that the damage was so catastrophic.

Akimov, Dyatlov, and Toptunov, their skin brown from the radiation, and their bodies wrenched from internal damage, had already been taken away to the medical center.

At 10:00 AM, Bryukhanov, the plant director, was informed that the reactor had been destroyed. Bryukhanov rejected the information, preferring to believe that the reactor was still intact. He informed Moscow that the reactor was intact and radiation was within normal limits.

Later that day, experts from around the Soviet Union came to Chernobyl, and found the horrifying truth. Thereactor had indeed been destroyed, and fifty tonsofradioactivefuelhad instantly evaporated. The wind blew the radioactive plume in a northwesterly direction. Belarus and Finland were going to be in the path of the radioactive cloud.

The Days Afterward

The secretive Soviet state was slow to act. Soviet bureaucracy debated whether to evacuate nearby cities, and how much land should be evacuated. They were slow in their response, slow to evacuate, and slow to inform the world of the disaster. It took over 36 hours before authorities began to evacuate nearby residents. Two days later, the nightly news (the fourth story) reported that one of the reactors was "damaged."

Within a few days, radiation detectors were going off all over the world. The Soviets continued to try to hide the issue from the world and their own residents.

Several months later, Bryukhanov was arrested, still believing that he did everything right. Dyatlov survived the radiation sickness, and was arrested in December of that year. He believed hewasascapegoatfor theaccident. Akimov died afewweeksafter thedisaster, but till the very end continued to say, "I did everything right. I don't know how it happened."

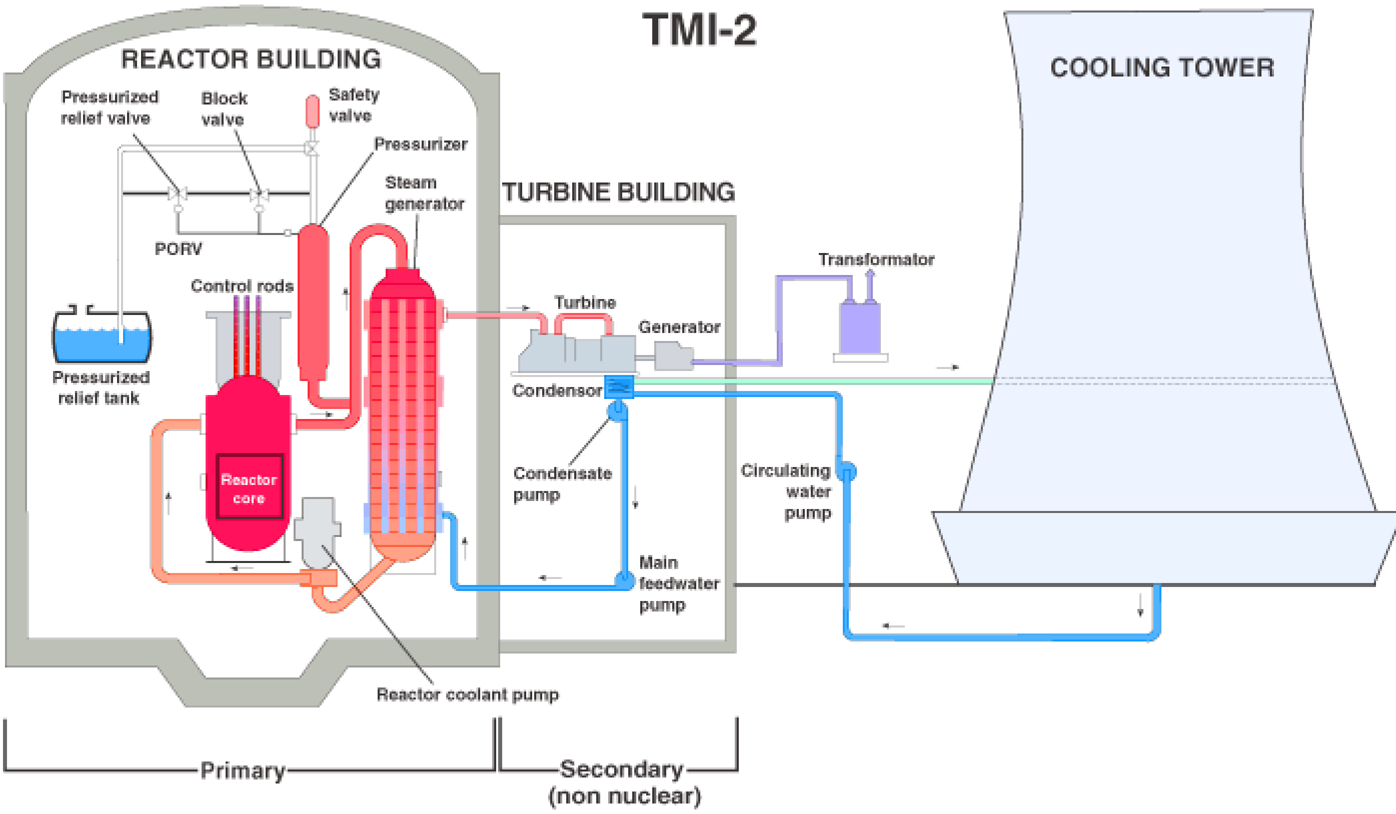
The radiation cloud on April 27th, 1986

THREE MILE ISLAND ACCIDENT

(*March 2001, minorupdateJan 2010*)

- **In 1979 at Three Mile Island nuclear power plant in USA a cooling malfunction caused part of the core to melt in the # 2 reactor. The TMI-2 reactor was destroyed.**
- **Some radioactive gas was released a couple of days after the accident, but not enough to cause any dose above background levels to local residents.**
- **There were no injuries or adverse health effects from the Three Mile Island accident.**

The Three Mile Island power station is near Harrisburg, Pennsylvania in USA. It had two pressurized water reactors. OnePWR wasof800 MWe(775 MWenet) and entered servicein 1974. It remains one of the best-performing units in USA. Unit 2 was of 906 MWe (880 MWe net) and almost brand new.



Theaccidentto unit2 happened at4 amon 28 March 1979 when thereactor wasoperating at 97% power. Itinvolved arelatively minor malfunction in thesecondary cooling circuitwhich caused the temperature in the primary coolant to rise. This in turn caused the reactor to shut down automatically. Shut down took about one second. At this point a relief valve failed to close, butinstrumentation did notrevealthefact, and so much oftheprimary coolantdrained away that the residual decay heat in the reactor core was not removed. The core suffered severe damage as a result.

The operators were unable to diagnose or respond properly to the unplanned automatic shutdown of the reactor. Deficient control room instrumentation and inadequate emergency response training proved to be root causes of the accident

The chain of events during the Three Mile Island Accident

Within seconds of the shutdown, the pilot-operated relief valve (PORV) on the reactor cooling system opened, as it was supposed to. About 10 seconds later it should have closed. But it remained open, leaking vital reactor coolant water to the reactor coolant drain tank. The operators believed the relief valve had shut because instruments showed them that a "close"signalwassentto thevalve. However, they did nothavean instrumentindicating the valve's actual position.

Responding to thelossofcooling water, high-pressureinjection pumpsautomatically pushed replacement water into the reactor system. As water and steam escaped through the relief valve, cooling water surged into thepressuriser, raising thewater levelin it. (Thepressuriser is a tank which is part of the primary reactor cooling system, maintaining proper pressure in the system. The relief valve is located on the pressuriser. In a PWR like TMI-2, water in the primary cooling system around the core is kept under very high pressure to keep it from boiling.)

Operatorsresponded by reducing theflowofreplacementwater. Their training told themthat thepressuriser water levelwastheonly dependableindication oftheamountofcooling water in the system. Because the pressuriser level was increasing, they thought the reactor system was too full of water. Their training told them to do all they could to keep the pressuriser from filling with water. If it filled, they could not control pressure in the cooling system and it might rupture.

Steam then formed in the reactor primary cooling system. Pumping a mixture of steam and water caused the reactor cooling pumps to vibrate. Because the severe vibrations could have damaged the pumps and made them unusale, operators shut down the pumps. This ended forced cooling of the reactor core. (The operators still believed the system was nearly full of water becausethepressuriser levelremained high.) However, asreactor coolantwater boiled away, the reactor?s fuel core was uncovered and became even hotter. The fuel rods were damaged and released radioactive material into the cooling water.

At 6:22 am operators closed a block valve between the relief valve and the pressuriser. This action stopped thelossofcoolantwater through thereliefvalve. However, superheated steam and gases blocked the flow of water through the core cooling system.

Throughout the morning, operators attempted to force more water into the reactor system to condense steam bubbles that they believed were blocking the flow of cooling water. During the afternoon, operators attempted to decrease the pressure in the reactor system to allow a low pressure cooling system to be used and emergency water supplies to be put into the system.

Cooling Restored

By late afternoon, operators began high-pressure injection of water into the reactor cooling system to increase pressure and to collapse steam bubbles. By 7:50 pm on 28 March, they restored forced cooling of the reactor core when they were ableto restartonereactor coolant pump. They had condensed steam so that the pump could run without severe vibrations.

Radioactive gases from the reactor cooling system built up in the makeup tank in the auxiliary building. During March 29 and 30, operators used a system of pipes and compressors to move the gas to waste gas decay tanks. The compressors leaked, and some radioactive gas was released to the environment.

The Hydrogen Bubble

When the reactor's core was uncovered, on the morning of 28 March, a high-temperature chemicalreaction between water and thezircaloy metaltubesholding thenuclear fuelpellets had created hydrogen gas. In the afternoon of 28 March, a sudden rise in reactor building pressure shown by the control room instruments indicated a hydrogen burn had occurred. Hydrogen gas also gathered at the top of the reactor vessel.

From 30 March through 1 April operators removed this hydrogen gas "bubble" by periodically opening the vent valve on the reactor cooling system pressuriser. For a time, regulatory (NRC) officials believed the hydrogen bubble could explode, though such an explosion was never possible since there was not enough oxygen in the system.

Cold Shutdown

After an anxious month, on 27 April operators established natural convection circulation of coolant. The reactor core was being cooled by the natural movement of water rather than by mechanical pumping. The plant was in "cold shutdown".

Public concern and confusion

When the TMI-2 accident is recalled, it is often in the context of what happened on Friday and Saturday, March 30-31. The drama of the TMI-2 accident-induced fear, stress and confusion on those two days. The atmosphere then, and the reasons for it, are described well in the book "*Crisis Contained, TheDepartmentofEnergyatThreeMileIsland*," by Philip L Cantelon and Robert C. Williams, 1982. This is an official history of the Department of Energy's role during the accident.

"Friday appears to have become a turning point in the history of the accident because of two events:thesudden risein reactor pressureshown by controlroominstrumentson Wednesday afternoon (the "hydrogen burn") which suggested a hydrogen explosion? became known to the Nuclear Regulatory Commission [that day]; and the deliberate venting of radioactive gases from the plant Friday morning which produced a reading of 1,200 millirems (12 mSv) directly above the stack of the auxiliary building.

"Whatmadethesesignificantwasaseriesofmisunderstandingscaused, in part, by problems of communication within various state and federal agencies. Because of confused telephone conversationsbetween peopleuninformed abouttheplant'sstatus, officialsconcluded thatthe 1,200 millirems (12 mSv) reading was an off-site reading. They also believed that another hydrogen explosion was possible, that the Nuclear Regulatory Commission had ordered evacuation and that a meltdown was conceivable.

"Garbled communications reported by the media generated a debate over evacuation. Whether or not there were evacuation plans soon became academic. What happened on

Friday was not a planned evacuation but a weekend exodus based not on what was actually happening at Three Mile Island but on what government officials and the media imagined might happen. On Friday confused communications created the politics of fear." (Page 50)

Throughout the book, Cantelon and Williams note that hundreds of environmental samples were taken around TMI during the accident period by the Department of Energy (which had the lead sampling role) or the then-Pennsylvania Department of Environmental Resources. But there were no unusually high readings, except for noble gases, and virtually no iodine. Readings were far below health limits. Yet a political storm was raging based on confusion and misinformation.

No Radiological Health Effects

TheThree Mile Islandaccident caused concerns about the possibility of radiation-induced health effects, principally cancer, in the area surrounding the plant. Because of those concerns, the Pennsylvania Department of Health for 18 years maintained a registry of more than 30,000 people who lived within five miles of Three Mile Island at the time of the accident. Thestate's registry was discontinued in mid 1997, withoutany evidenceof unusual health trends in the area.

Indeed, more than a dozen major, independent health studies of the accident showed no evidence of any abnormal number of cancers around TMI years after the accident. The only detectable effect was psychological stress during and shortly after the accident.

The studies found that the radiation releases during the accident were minimal, well below any levelsthathavebeen associated with health effectsfromradiation exposure. Theaverage radiation dose to people living within 10 miles of the plant was 0.08 millisieverts, with no more than 1 millisievert to any single individual. The level of 0.08 mSv is about equal to a chestX-ray, and 1 mSv isaboutathird oftheaveragebackground levelofradiation received by U.S. residents in a year.

In June1996, 17 yearsafter theTMI-2 accident, Harrisburg U.S. DistrictCourtJudgeSylvia Rambo dismissed a class action lawsuit alleging that the accident caused health effects. The plaintiffs have appealed Judge Rambo's ruling. The appeal is before the U.S. Third Circuit Court of Appeals. However, in making her decision, Judge Rambo cited:

· Findings that exposure patterns projected by computer models of the releases compared so well with data from the TMI dosimeters (TLDs) available during the accident that the dosimeters probably were adequate to measure the releases.

·Thatthemaximumoffsitedosewas, possibly, 100 millirem(1 mSv), and thatprojected fatal cancers were less thanone.

· The plaintiffs' failure to prove their assertion that one or more unreported hydrogen "blowouts"in thereactor systemcaused oneor moreunreported radiation "spikes", producing a narrow yet highly concentrated plume of radioactive gases.

Judge Rambo concluded: "The parties to the instant action have had nearly two decades to muster evidencein supportoftheir respectivecases.... Thepaucity ofproofalleged in support of Plaintiffs' case is manifest. The court has searched the record for any and all evidence which construed in a light most favourable to Plaintiffs creates a genuine issue of material fact warranting submission of their claims to a jury. This effort has been in vain."

More than a dozen major, independent studies have assessed the radiation releases and possible effects on the people and the environment around TMI since the 1979 accident at TMI-2. The most recent was a 13-year study on 32,000 people. None has found any adverse health effects such as cancers which might be linked to the accident.

The TMI-2 Cleanup

The cleanup of the damaged nuclear reactor system at TMI-2 took nearly 12 years and cost approximately US$973 million. The cleanup was uniquely challenging technically and radiologically. Plant surfaces had to be decontaminated. Water used and stored during the cleanup had to be processed. And about 100 tonnes of damaged uranium fuel had to be removed from the reactor vessel--all without hazard to cleanup workers or the public.

Acleanup plan wasdeveloped and carried outsafely and successfully by ateamofmorethan 1000 skilled workers. Itbegan in August1979, with thefirstshipmentsofaccident-generated low-level radiological waste to Richland, Washington. In the cleanup's closing phases, in 1991, finalmeasurementsweretaken ofthefuelremaining in inaccessiblepartsofthereactor vessel. Approximately onepercentofthefueland debrisremainsin thevessel. Also in 1991, the last remaining water was pumped from the TMI-2 reactor. The cleanup ended in December 1993, when Unit 2 received a license from the NRC to enter Post Defueling Monitored Storage (PDMS).

Early in the cleanup, Unit 2 was completely severed from any connection to TMI Unit 1. TMI-2 today isin long-termmonitored storage. No further useofthenuclear partoftheplant isanticipated. Ventilation and rainwater systemsaremonitored. Equipmentnecessary to keep the plant in safe long-term storage is maintained.

Defueling theTMI-2 reactor vesselwastheheartofthecleanup. Thedamaged fuelremained underwater throughout the defueling. In October 1985, after nearly six years of preparations, workers standing on a platform atop the reactor and manipulating long-handled tools began lifting the fuel into canisters that hung beneath the platform. In all, 342 fuel canisters were shipped safely for long-term storage at the Idaho National Laboratory, a program that was completed in April 1990.

TMI-2 cleanup operations produced over 10.6 megalitres of accident-generated water that was processed, stored and ultimately evaporated safely.

In February 1991, the TMI-2 Cleanup Program was named by the National Society of Professional Engineers as one of the top engineering achievements in the U.S. completed during 1990.

In 2010 the generator was sold by FirstEnergy to Progress Energy to upgrade its Harris nuclear power plant in North Carolina. It is being shipped in two parts, the rotor, which weighs 170 tonnes, and the stator, which weighs about 500 tonnes.

The NRC website has afactsheet on Three Mile Island.

TMI-1: Safe and World-Class

From its restart in 1985, Three Mile Island Unit 1 has operated at very high levels of safety and reliability. Application of the lessons of the TMI-2 accident has been a key factor in the plant's outstanding performance.

In 1997, TMI-1 completed the longest operating run of any light water reactor in the history of nuclear power worldwide - 616 days and 23 hours of uninterrupted operation. (That run wasalso thelongestatany steam-driven plantin theU.S., including plantspowered by fossil fuels.) And in October 1998, TMI employees completed threemillion hours of work without a lost-work day accident.

AtthetimeoftheTMI-2 accident, TMI-1 wasshutdown for refueling. Itwaskeptshutdown during lengthy proceedings by the Nuclear Regulatory Commission. During the shutdown, the plant was modified and training and operating procedures were revamped in light of the lessons of TMI-2.

When TMI-1 restarted in October 1985, GeneralPublicUtilitiespledged thattheplantwould be operated safely and efficiently and would become a leader in the nuclear power industry. Those pledges have been kept.

- The plant's capability factor for 1987, including almost three months of a five-month refueling and maintenanceoutage, was74.1 percent, compared to an industry average of 62 percent. (Capability factor refers to the amount of electricity generated compared to the plant'smaximum capacity.)
- In 1988 a 1.3% (11 MWe) uprate was licensed.
- For 1989, TMI-1's capability factor was 100.03 percent and the best of 357 nuclear power plants worldwide, according to *NucleonicsWeek*.
- In 1990-91, TMI-1 operated 479 consecutive days, the longest operating run at that point in the history of US commercial nuclear power. It was named by the NRC as one of the four safest plants in the country during this period.
- By the end of 1994, TMI-1 was one of the first two plants in the history of US commercial nuclear power to achieve a three-year average capability factor of over 90% (TMI-1 had 94.3%).
- In October 1998, TMI workers completed two full years without a lost workday injury.
- Since its restart, TMI-1 has earned consistently high ratings in the NRC's program, Systematic Assessment of Licensee Performance (SALP).
- In 2009, the TMI-1 operating licence was renewed, extending it life by 20 years to 2034.
- Immediately following this, both steam generators were replaced as TMI's "largest capital project to date"

In 1999, TMI-1 waspurchased by AmerGen, anewjointventurebetween British Energy and PECO Energy. In 2003 the BE share was sold so that the plant became wholly-owned by Exelon, PECO's successor. It is now listed as producing 786 MWe net.

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Training improvements

Training reforms are among the most significant outcomes of the TMI-2 accident. Training became centred on protecting a plant's cooling capacity, whatever the triggering problem mightbe. AtTMI-2, theoperatorsturned to abook ofproceduresto pick thosethatseemed to fittheevent. Nowoperatorsaretaken through asetof"yes-no"questionsto ensure, *first*, that thereactor'sfuelcoreremainscovered. *Then*they determinethespecificmalfunction. Thisis known as a "symptom-based" approach for responding to plant events. Underlying it is a style of training that gives operators a foundation for understanding both theoretical and practical aspects of plant operations.

The TMI-2 accident also led to the establishment of the Atlanta-based Institute of Nuclear Power Operations (INPO) and its National Academy for Nuclear Training. These two industry organisationshavebeen effectivein promoting excellencein theoperation ofnuclear plants and accrediting their training programs.

INPO was formed in 1979. The National Academy for Nuclear Training was established under INPO's auspices in 1985. TMI's operator training program has passed three INPO accreditation reviews since then.

Training hasgonewellbeyond button-pushing. Communicationsand teamwork, emphasizing effective interaction among crew members, are now part of TMI's training curriculum.

Close to half of the operators' training is in a full-scale electronic simulator of the TMI controlroom. The$18 million simulator permits operatorsto learn and betested on allkinds of accident scenarios.

Increased safety & reliability

Disciplinesin training, operationsand eventreporting thatgrewfromthelessonsoftheTMI-2 accident have made the nuclear power industry demonstrably safer and more reliable. Those trends have been both promoted and tracked by the Institute for Nuclear Power Operations(INPO). To remain in good standing, anuclear plantmustmeetthehigh standards set by INPO as well as the strict regulation of the US Nuclear Regulatory Commission.

A key indicator is the graph of significant plant events, based on data compiled by the Nuclear Regulatory Commission. The number of significant events decreased from 2.38 per reactor unit in 1985 to 0.10 at the end of 1997.

On the reliability front, the median capability factor for nuclear plants - the percentage of maximum energy that a plant is capable of generating - increased from 62.7 percent in 1980 to almost 90 percent in 2000. (The goal for the year 2000 was 87 percent.)

Other indicators for US plants tracked by INPO and its world counterpart, the World Association of Nuclear Operators (WANO) are the unplanned capability loss factor, unplanned automatic scrams, safety system performance, thermal performance, fuel reliability, chemistry performance, collective radiation exposure, volume of solid radioactive waste and industrial safety accident rate. All are reduced, that is, improved substantially, from 1980.

UNIT-IV

RESPONSIBILITIES & RIGHTS

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupationalcrime-professionalrights-employee rights-IntellectualPropertyRights(IPR) -discrimination.

COLLEGIALITY AND LOYALTY

Colleagues are those explicitly united in a common purpose and respecting each other's abilities to work toward that purpose. A colleague is an associate in a profession or in a civil or ecclesiastical office.

Thus, the word *collegiality* and loyality can connote respect for another's commitment to the common purpose and ability to work toward it.

Case Study:

The unique structural characteristic of a collegial body such as the Supreme Court is the equality of formal authority of the members. Tension exists between the individual responsibility to formviews in each caseand thenecessity for cooperation to producecollective decisions in the Court's collegial structure. Cooperation and the appearance of unity serve to increase power and respect for a collegial institution. Chief Justice John Marshall arranged accommodations in one boardinghouse to foster fellowship and developed the single opinion of theCourtto createasymbolofjudicialsolidarity (seeSeriatimOpinions). Yet, within theCourt's collegial structure, contemporary justices freely exhibit individualism, as seen in the increase of separate opinions.

Effective action requires the cooperative participation of every justice. Collegiality does not mandate unanimity but does demand loyalty to the institution and civil treatment of colleagues. Evidences of the justices' strong commitment to the Court are long tenures, unanimity in cases that threaten institutional integrity, and resolution of internal difficulties without appeals for external intervention. Collegial relationships sometimes may be threatened by biting opinions, such asthosewritten by JusticeAntonin Scaliadirecting harsh languageatopposing justices, and by divisive cases like *Bush* v. *Gore*. Still, justices assert that disagreements have not affected their relationships and that they remain friends who respect each other and enjoy each other's company. Justices have maintained cordial relations across ideological lines and warm friendships have developed between some pairs with shared values. Justice Ruth Bader Ginsburg, for instance, recounts a visit by Justice Scalia to give her a draft of his dissenting opinion so she would have time to respond. Court practices remind the justices of their mutual dependence, equal power, and personal esteem; for example, the handshakes before conference initiated by Chief Justice Melville W. Fuller, and the luncheons, letters, or gifts for significant personal occasions.

Other structural characteristics and changes in the Court's environment have affected the requirements of collegiality. The Court has remained a small group in size; therefore, skillful chief justices can satisfy individuals and harmonize Court functioning. However, the growth of the federal court system and the Court bureaucracy has diverted the chief justice's attention to other duties (see Bureaucratization of the Federal Judiciary). In the nineteenth century, short Court terms, circuit duties, and home offices limited contacts among justices. Longer Court terms and a separate building have brought justices into proximity, and the longevity of the current Court (with no personnel changes since 1994) has reinforced the justices' collegiality. Conversely, heavy workloads, personal staffs, and new office technologies have focused their energies upon individual rather than collective decision making. Resolution of the tensions between equal authority and collective duty requires different strategies in the twenty 6first century, when the Court has become a powerful institution and the justices work in relative isolation.

COLLECTIVE BARGAINING

Collective bargaining is a process of voluntary negotiation between employers and trade unions aimed at reaching agreements which regulate working conditions. Collective agreements usually set out wage scales, working hours, training, health and safety, overtime, grievance mechanisms and rights to participate in workplace or company affairs.[1]

The union may negotiate with a single employer (who is typically representing a company's shareholders) or may negotiate with a federation of businesses, depending on the country, to reach an industry wide agreement. A collective agreement functions as a labor contract between an employer and one or more unions. Collective bargaining consists of the process of negotiation between representatives of a union and employers (generally represented by management, in some countries [*which?*] by an employers' organization) in respect of the terms and conditions of employment of employees, such as wages, hours of work, working conditions and grievance-procedures, and about the rights and responsibilities of trade unions. The parties often refer to the result of the negotiation as a *collective bargaining agreement* (CBA) or as a *collective employment agreement* (CEA).

Different economic theories provide a number of models intended to explain some aspects of collective bargaining:

1. Theso-called Monopoly Union Model(Dunlop, 1944) statesthatthemonopoly union has the power to maximise the wage rate; the firm then chooses the level of employment. (Recent literature has started to abandon this model.[*citationneeded*]
2. The Right-to-Manage model, developed by the British school during the 1980s (Nickell) views the labour union and the firm bargaining over the wage rate according to a typical Nash Bargaining Maximin (written as ! = U #$^{\beta}$ $^{1-\beta}$, where U is the utility function of the labour union, #theprofitofthefirmand "representsthebargaining power ofthelabour unions).

3. Theefficientbargainingmodel(McDonald and Solow, 1981) seestheunion and thefirm bargaining over both wagesand employment(or, morerealistically, hoursofwork). [*citation needed*]

The underlying idea of collective bargaining is that the employer and employee relations should not be decided unilaterally or with the intervention of any third party. Both parties must reconcile their differences voluntarily through negotiations, yielding some concessions and making sacrifices in the process. Both should bargain from a position of strength; there should be no attempt to exploit the weaknesses or vulnerability of one party. With the growth of union movement all over the globe and the emergence of employers' association, the collective bargaining process has undergone significant changes. Both parties have, more or less, realized the importance of peaceful co-existence for their mutual benefit and continued progress

CONFIDENTIALITY

Confidentiality is an ethical principle associated with several professions (e.g., medicine, law, religion, professional psychology, and journalism). In ethics, and (in some places) in law and alternative forms of legal dispute resolution such as mediation, some types of communication between aperson and oneoftheseprofessionalsare"privileged"and may notbe discussed or divulged to third parties. In thosejurisdictionsin which thelawmakesprovision for such confidentiality, there are usually penalties for its violation.

Confidentiality has also been defined by the International Organization for Standardization (ISO) in ISO-17799 [1] as "ensuring that information is accessible only to those authorized to haveaccess"and isoneofthecornerstonesofinformation security. Confidentiality isoneofthedesign goalsfor many cryptosystems, madepossiblein practiceby thetechniquesof modern cryptography.

Confidentiality ofinformation, enforced in an adaptation ofthemilitary'sclassic"need to knowβ principle, forms the cornerstone of information security in today's corporations. The so called 'confidentiality bubble' restricts information flows, with both positive and negative consequences.[2]

Both theprivilegeand theduty servethepurposeofencouraging clientsto speak frankly about their cases. This way, lawyers will be able to carry out their duty to provide clients with zealous representation. Otherwise, the opposing side may be able to surprise the lawyer in court with something which hedid notknowabouthisclient, which makesboth lawyer and clientlook stupid. Also, a distrustful client might hide a relevant fact which he thinks is incriminating, but which a skilled lawyer could turn to the client's advantage (for example, by raising affirmative defenseslike self-defense).

However, most jurisdictions have exceptions for situations where the lawyer has reason to believethattheclientmay killor seriously injuresomeone, may causesubstantialinjury to the financial interest or property of another, or is using (or seeking to use) the lawyer's services to perpetrate a crime or fraud.

In such situations the lawyer has the discretion, but not the obligation, to disclose information designed to prevent the planned action. Most states have a version of this discretionary disclosure rule under Rules of Professional Conduct, Rule 1.6 (or its equivalent).

A few jurisdictions have made this traditionally discretionary duty mandatory. For example, see the New Jersey and Virginia Rules of Professional Conduct, Rule 1.6.

In somejurisdictionsthelawyer musttry to convincetheclientto conformhisor her conductto t he boundaries of the law before disclosing any otherwise confidential information.

Note that these exceptions generally do not cover crimes that have already occurred, *even* in extreme cases where murderers have confessed the location of missing bodies to their lawyers butthepolicearestilllooking for thosebodies. TheU.S. SupremeCourtand many statesupreme courtshaveaffirmed therightofalawyer to withhold information in such situations. Otherwise, it would be impossible for any criminal defendant to obtain a zealous defense.

California is famous for having one of the strongest duties of confidentiality in the world; its lawyers must protect client confidences at "every peril to himself or herself." Until an amendment in 2004, California lawyers were not even permitted to disclose that a client was about to commit murder.

Recent legislation in the UK curtails the confidentiality professionals like lawyers and accountants can maintain at the expense of the state. Accountants, for example, are required to disclose to the state any suspicions of fraudulent accounting and, even, the legitimate use of tax saving schemes if those schemes are not already known to the tax authorities.

INTELLECTUAL PROPERTY RIGHTS

Intellectual property (**IP**) is a term referring to a number of distinct types of creations of themind for which property rightsarerecognized—and thecorresponding fieldsoflaw. [1] Under intellectual property law, owners are granted certain exclusive rights to a variety of intangible assets, such as musical, literary, and artistic works; discoveries and inventions; and words, phrases, symbols, and designs. Common types of intellectual property include copyrights, trademarks, patents, industrial design rightsand trade secretsin some jurisdictions.

Richard Stallman argues that, although the term *intellectual property* is in wide use, it should be rejected altogether, because it "systematically distorts and confuses these issues, and its use was and is promoted by those who gain from this confusion." He claims that the term "operates as a catch-all to lump together disparate laws [which] originated separately, evolved differently, cover different activities, have different rules, and raise different public policy issues" and that it confuses these monopolies with ownership of limited physical things [15]

Stallman advocates referring to copyrights, patents and trademarks in the singular and warns against abstracting disparate laws into a collective term.

Somecriticsofintellectualproperty, such as thosein thefreeculturemovement, pointat intellectual monopolies as harming health, preventing progress, and benefiting concentrated intereststo thedetrimentofthemasses, [16][17] and arguethatthepublicinterestisharmed by ever expansivemonopoliesin theformofcopyrightextensions, softwarepatentsand businessmethod patents.

There is also criticism [*by whom?*] because strict intellectual property rights can inhibit the flow of innovations to poor nations. Developing countries have benefitted from the spread of developed country technologies, such as the internet, mobile phone, vaccines, and high-yielding grains. Many intellectual property rights, such as patent laws, arguably go too far in protecting those who produce innovations at the expense of those who use them. [*citation needed*] The Commitment to Development Index measures donor government policies and ranks them on the "friendliness" of their intellectual property rights to the developing world.

Some libertarian critics of intellectual property have argued that allowing property rights in ideas and information creates artificial scarcity and infringes on the right to own tangible property. Stephan Kinsella uses the following scenario to argue this point:

Imagine the time when men lived in caves. One bright guy—let's call him Galt-Magnon—decidesto build alog cabin on an open field, near hiscrops. To besure, thisisagood idea, and others notice it. They naturally imitate Galt-Magnon, and they start building their own cabins. But the first man to invent a house, according to IP advocates, would have a right to prevent others from building houses on their own land, with their own logs, or to charge them a fee if they do build houses. It is plain that the innovator in these examples becomes a partial owner ofthetangibleproperty (e.g., land and logs) ofothers, duenotto firstoccupation and use ofthatproperty (for itisalready owned), butdueto hiscoming up with an idea. Clearly, thisrule flies in the face of the first-user homesteading rule, arbitrarily and groundlessly overriding the very homesteading rule that isat the foundation of all property rights. [18]

Other criticism of intellectual property law concerns the tendency of the protections of intellectual property to expand, both in duration and in scope. The trend has been toward longer copyrightprotection [19] (raising fearsthatitmay someday beeternal). [20][21][22][23] In addition, the developers and controllers of items of intellectual property have sought to bring more items under the protection. Patents have been granted for living organisms, [24] and colors have been trademarked.[25] Because they are systems of government-granted monopolies copyrights, patents, and trademarks are called intellectual monopoly privileges, (IMP) a topic on which several academics, including Birgitte Andersen[26] and Thomas Alured Faunce[27] have written.

In 2005 the RSA launched the Adelphi Charter, aimed at creating an international policy statement to frame how governments should make balanced intellectual property law.

Intellectual Property Rights

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Intellectual property rights is a legal concept that confers rights to owners and creators of the work, for their intellectual creativity. Such rights can be granted for areas related to literature, music, invention etc, which are used in the business practices. In general, the intellectual property law offers exclusionary rights to the creator or inventor against any misappropriation or useof work without his/her prior knowledge. Intellectual property law establishes an equilibrium by granting rights for limited duration of time.

Every nation has framed their own intellectual property laws. But on international level it is governed by the World Intellectual Property Organization (WIPO). The Paris Convention for the Protection of Industrial Property in 1883 and the 'Berne Convention for the Protection of Literary and Artistic Works' in 1886 were first conventions which have recognized the importance of safeguarding intellectual property. Both the treaties are under the direct administration of the WIPO. The WIPO convention lays down following list of the activities or work which are covered by the intellectual property rights-

- Industrial designs
- Scientific discoveries
- Protection against unfair competition
- Literary, artistic and scientific works
- Inventions in all fields of human endeavor
- Performances of performing artists, phonograms and broadcasts
- Trademarks, service marks and commercial names and designations
- All other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields.

Types of Intellectual Property Rights

Intellectual Property Rights signifies to the bundle of exclusionary rights which can be further categorized into the following heads-

- **Copyright**

  Copyright, one of the form of intellectual property right, offers exclusive rights for protecting the authorship of original & creative work like dramatic, musical and literary in nature. Symbolized as "©", here the term ....

  Patent

  A patent is termed as the exclusionary rights given by the government or the authorized authority to its inventor for a particular duration of time, in respect of his invention. It is the part of the intellectual property right ....

  Trademark

The trademark or trade mark, symbolized as the â„¢ and ®, is the distinctive sign or indication which is used for signifying some kind of goods or/and services and is distinctively used across the business ....

- **Trade Secrets**

Trade secret points towards a formula, pattern, any instrument, design which is kept confidential and through which any business or trade can edge over its rival and can enjoy economic gain. Trade secrets can be ....

- **Utility Model**

The utility model is the intellectual property right for protecting the inventions. It is somehow described as the statutory monopoly which is bestow upon for the fixed duration of time in exchange to the inventor for ....

- **Geographical Indication**

Geographical Indication (GI) signifies to the name or sign, used in reference to the products which are corresponding to the particular geographical area or somewhat related to the origin like town, region or nation.

- **Industrial Design Rights**

Industrial design rights are defined as the part of the intellectual property rights which confers the rights of exclusivity to the visual designs of objects whichare generally not popular utilitarian. It safeguards the ....

Advantages of Intellectual Property Rights

Intellectual property rights help in providing exclusive rights to creator or inventor, thereby induces them to distribute and share information and data instead of keeping it confidential. It provides legal protection and offers them incentive of their work. Rights granted under the intellectual property act helps in socio and economic development.

Intellectual Property Rights in India

India has defined the establishment of statutory, administrative and judicial framework for protecting the intellectual property rights in the Indian territory, whether they connotes with the copyright, patent, trademark, industrial designs or with other parts.

Tuning with the changing industrial world, the intellectual property rights have continued to strengthen its position in the India. In 1999, the government has passed the important legislation in relation to the protection of intellectual property rights on the terms of the worldwide practices and in accordance to the India's obligations under the Trade Related Aspects of Intellectual Property Rights. It consists of-

- The Patents(Amendment) Act, 1999 which was passed on 10th March, 1999 in the Indian Parliament for amending the Patents Act of 1970 which in turns facilitate to establish the mail box system for filing patents and accords with the exclusive marketing rights for the time period of 5 years.
- The Trade Marks Bill, 1999 was passed in the India parliamentduring the winter session for replacing the Trade and Merchandise Marks Act, 1958. It was passed on 23rd December, 1999.
- The Copyright(Amendment) Act, 1999 was passed by both upper house and lower house of the Indian parliament and was later on signed by the Indian president on 30th December, 1999.
- The sui generis legislation was approved by both houses of the Indian parliament on 23rd December, 1999 and was named as the Geographical Indications of Goods (Registration & Protection) Bill, 1999.
- The Industrial Designs Bill, 1999 was passed in the Upper House of the Indian parliament for replacing the Designs Act, 1911.
- The Patents (Second Amendment) Bill, 1999 was itroduced in the upper house of the parliament for further amending the Patents Act 1970 andmaking it compliance with the TRIPS.

Along with the above legislative measures, the Indian government has introduced several changes for streamlining and bolstering the intellectual property administration system in the nation. Several projects concerning to the modernizing of the patent information services and trademark registry have been undergone with the help of the World Intellectual Property Organization/ United Nations Development Programme.

DISCRIMINATION

Discrimination is a sociological term referring to the prejudicial treatment of an individual based solely on their membership (whether voluntary or involuntary) in a certain group or category. Discrimination is the *actual behavior* towards members of another group. It involves excluding or restricting members of one group from opportunities that are available to other groups.[1] The United Nations explains: "Discriminatory behaviors take many forms, but they all involve some form of exclusion or rejection." [2] Discriminatory laws such as redlining have existed in many countries. In some countries, controversial attempts such as racial quotas have been used to redress negative effects of discrimination.

Racial discrimination differentiates between individuals on the basis of real and perceived racial differences, and hasbeen officialgovernmentpolicy in severalcountries, such asSouth Africain theapartheidera, and the USA.

In the United States, racial profiling of minorities by law enforcement officials has been called racial discrimination. [3] As early as 1865, the Civil Rights Act provided a remedy for intentional race discrimination in employment by private employers and state and local public employers. TheCivilRightsActof1871appliesto publicemploymentor employmentinvolving state action prohibiting deprivation of rights secured by the federal constitution or federal laws through action under color of law. Title VII is the principal federal statute with regard to employment discrimination prohibiting unlawful employment discrimination by public and private employers, labor organizations, training programs and employment agencies based on race or color,religion, gender, and national origin.

TitleVII also prohibitsretaliation againstany person for opposing any practiceforbidden by statute, or for making acharge, testifying, assisting, or participating in aproceeding under the statute. The Civil Rights Act of 1991 expanded the damages available in Title VII cases and granted Title VII plaintiffs the right to a jury trial. Title VII also provides that race and color discrimination against every race and color is prohibited.

In the UK the inquiry following the murder of Stephen Lawrence accused the police of institutional racism.

- Weaver v NATFHE (now part of the UCU) Race/sex dicrimination case. An Industrial (Employment) Tribunalin theUKin 1987 decided thatatradeunion wasjustified in not assisting a black woman member complaining of racist/sexist harassment, regardless of the merits of the case, because the accused male would lose his job. The Employment Appeal Tribunal upheld the decision, which still stands today as the definitive legal precedent in this field. It is also known as the Bournville College Racial Harassment issue.

Within the criminal justice system in some Western countries, minorities are convicted and imprisoned disproportionately when compared with whites. [4][5] In 1998, nearly one out of three black men between theagesof 20-29 were in prison or jail, on probation or paroleon any given day in the United States. [6] First Nations make up about 2% of Canada's population, but account for 18% ofthefederalprison population asof2000. [7] According to theAustralian government's June2006 publication ofprison statistics, indigenouspeoplesmakeup 24% oftheoverallprison population in Australia. [8] In 2004, Māori made up just 15% of the total population of New Zealandbut49.5% ofprisoners. M$oriwereentering prison at8 timestherateofnon-M$ori. [9] A quarter ofthepeoplein England'sprisonsarefroman ethnicminority. TheEquality and Human Rights Commission found that five times more black people than white people per head of population in England and Wales are imprisoned. Experts and politicians said over-representation of black men was a result of decades of racial prejudice in the criminal justice system.[10]

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Main article: Ageism

Agediscriminationis discrimination on thegroundsof age. Although theoretically theword can refer to the discrimination against any age group, age discrimination usually comes in one of three forms: discrimination against youth (also called adultism), discrimination against those 40 years old or older,[11] and discrimination against elderly people.

In the United States, the Age Discrimination in Employment Act prohibits employment discrimination nationwide based on age with respect to employees 40 years of age or older. The Age Discrimination in Employment Act also addresses the difficulty older workers face in obtaining new employment after being displaced from their jobs, arbitrary age limits.

On the other hand, the UK Equality Act 2010 protects young employees as well as old. Other countries go even further and make age discrimination a criminal offence.[12]

In many countries, companies more or less openly refuse to hire people above a certain age despite the increasing lifespans and average age of the population. The reasons for this range from vague feelings younger people are more "dynamic" and create a positive image for the company, to more concrete concerns about regulations granting older employees higher salaries or other benefits without these expenses being fully justified by an older employees' greater experience. Unions cite age as the most common form of discrimination in the workplace. [13] Workers ages 45 and over form a disproportionate share of the long-term unemployed – those who have been out of work for six months or longer, according to the U.S. Bureau of Labor Statistics.[14]

Somepeopleconsider thatteenagersand youth(around 15–25 yearsold) arevictimsofadultism, age discrimination framed as a paternalistic form of protection. In seeking social justice, they feelthatitisnecessary to removetheuseofafalsemoralagendain order to achieveagency and empowerment.

Thisperspectiveisbased on thegroundsthatyouth should betreated morerespectfully by adults and not as second-class citizens. Some suggest that social stratification in age groups causes outsiders to incorrectly stereotype and generalize the group, for instance that all adolescents are equally immature, violentor rebellious, listen to rock tunes, and do drugs. Somehaveorganized groups against age discrimination.

Ageism is the causal effect of a continuum of fears related to age. [*citation needed*] This continuum includes:

- Ephebiphobia: the fear of youth.
- Gerontophobia: the fear of elderly people.
- Pediaphobia: the fear of infants or small children.

Related terms include:

- Adultism: Also called adultarchy, adult privilege, and adultcentrism/adultocentrism, this is the wielding of authority over young people and the preference of adults before children and youth.
- Jeunism:Also called "youthism"istheholding ofbeliefsor actionstaken thatpreference 'younger' people before adults.

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Though gender discrimination and sexismrefers to beliefs and attitudes in relation to thegender ofaperson, such beliefsand attitudesareofasocialnatureand do not, normally, carry any legal consequences. **Sexdiscrimination**, on the other hand, may have legal consequences.

Though what constitutes sex discrimination varies between countries, the essence is that it is an adverse action taken by one person against another person that would not have occurred had the person been ofanother sex. Discrimination ofthatnaturein certain enumerated circumstancesis illegal in many countries.

Currently, discrimination based on sex is defined as adverse action against another person, that would not have occurred had the person been of another sex. This is considered a form of prejudiceand is illegal in certain enumerated circumstances in most countries.

Sexual discrimination can arise in different contexts. For instance an employee may be discriminated againstby being asked discriminatory questionsduring ajob interview, or because an employer did not hire, promote or wrongfully terminated an employee based on his or her gender, or employers pay unequally based on gender.

In an educational setting there could be claims that a student was excluded from an educational institution, program, opportunity, loan, studentgroup, or scholarship dueto hisor her gender. In the housing setting there could be claims that a person was refused negotiations on seeking a house, contracting/leasing a house or getting a loan based on his or her gender. Another setting where there have been claims of gender discrimination is banking; for example if one is refused credit or is offered unequal loan terms based on one's gender.[15]

Another setting wherethereisusually gender discrimination iswhen oneisrefused to extend his or her credit, refused approval of credit/loan process, and if there is a burden of unequal loan terms based on one's gender.

Socially, sexual differences have been used to justify different roles for men and women, in some cases giving rise to claims of primary and secondary roles.[16]

Whilethereare alleged non-physicaldifferencesbetween men and women, major reviewsofthe academic literature on gender difference find only a tiny minority of characteristics where there are consistent psychological differences between men and women, and these relate directly to experiences grounded in biological difference. [17] However, there are also some psychological differences in regard to how problems are dealt with and emotional perceptions and reactions which may relate to hormones and the successful characteristics of each gender during longstanding roles in past primitive lifestyles.

Unfair discrimination usually follows thegender stereotypingheld by a society.

The United Nations had concluded that women often experience a "glass ceiling" and that there are no societies in which women enjoy the same opportunities as men. The term "glass ceiling" is used to describe a perceived barrier to advancement in employment based on discrimination, especially sex discrimination.

In theUnited Statesin 1995, theGlassCeiling Commission, agovernment-funded group, stated: "Over half of all Master's degrees are now awarded to women, yet 95% of senior-level managers, ofthetop Fortune1000 industrialand 500 servicecompanies are men. Ofthem, 97% are white." In its report, it recommended affirmative action, which is the consideration of an employee's gender and race in hiring and promotion decisions, as a means to end this form of discrimination.[18] In 2008, women accounted for 51% of all workers in the high-paying management, professional, and related occupations. They outnumbered men in such occupations as public relations managers; financial managers; and human resource managers.[19]

TheChina'sleading headhunter, Chinahr.com, reported in 2007 thattheaveragesalary for white-collar men was 44,000 yuan ($6,441), compared with 28,700 yuan ($4,201) for women.[20]

The PwC research found that among FTSE 350 companies in the United Kingdom in 2002 almost 40% of senior management posts were occupied by women. When that research was repeated in 2007, the number of senior management posts held by women had fallen to 22%.[21]

Transgender individuals, both male to female and female to male, often experience problems which often lead to dismissals, underachievement, difficulty in finding a job, social isolation, and, occasionally, violent attacks against them. Nevertheless, the problem of gender discrimination does not stop at trandgender individuals nor with women. Men are often the victimin certain areasofemploymentasmen begin to seek work in officeand childcaresettings traditionally perceived as "women's jobs". One such situation seems to be evident in a recent case concerning alleged YMCA discrimination and a Federal Court Case in Texas. [*citation needed*] Thecaseactually involvesalleged discrimination againstboth men and blacksin childcare, even when they pass the same strict background tests and other standards of employment. It is currently being contended in federal court, as of fall 2009, and sheds light on how a workplace dominated by a majority (- women in this case) sometimes will seemingly "justify" whatever they wish to do, regardlessofthelaw. Thismay bedoneasan effortatself-protection, to uphold traditional societal roles, or some other faulty, unethical or illegal prejudicial reasoning.

Affirmative action also leads to white men being discriminated against for entry level and blue collar positions. An employer cannot hire a white man with the same "on paper" qualifications over a woman or minority worker or the employer will face prosecution

UNIT – V

GLOBAL ISSUES

Syllabus: Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE),India, etc.

MULTINATIONAL CORPORATIONS

A multinational corporation (MNC), also called a transnational corporation (TNC), or multinational enterprise (MNE), is a corporation or an enterprise that manages production or delivers services in more than one country. It can also be referred to as an international corporation. The International Labour Organization (ILO) has defined[citation needed] an MNC as a corporation that has its management headquarters in one country, known as the home country, and operates in several other countries, known as host countries.

The Dutch East India Company was the first multinational corporation in the world and the first company to issue stock. It was also arguably the world's first megacorporation, possessing quasi-governmental powers, including the ability to wage war, negotiate treaties, coin money, and establish colonies.

The first modern multinational corporation is generally thought to be the East India Company. Many corporations have offices, branches or manufacturing plants in different countries from where their original and main headquarters is located.

Some multinational corporations are very big, with budgets that exceed some nations' GDPs. Multinational corporations can have a powerful influence in local economies, and even the world economy, and play an important role in international relations and globalization

Multinational corporations have played an important role in globalization. Countries and sometimes subnational regions must compete against one another for the establishment of

MNC facilities, and the subsequent tax revenue, employment, and economic activity. To compete, countries and regional political districts sometimes offer incentives to MNCs such as tax breaks, pledges of governmental assistance or improved infrastructure, or lax environmental and labor standards enforcement. This process of becoming more attractive to foreign investment can be characterized as a race to the bottom, a push towards greater autonomy for corporate bodies, or both.

However, some scholars for instance the Columbia economist Jagdish Bhagwati, have argued that multinationals are engaged in a 'race to the top.' While multinationals certainly regard a low tax burden or low labor costs as an element of comparative advantage, there is no evidence to suggest that MNCs deliberately avail themselves of lax environmental regulation or poor labour standards. As Bhagwati has pointed out, MNC profits are tied to operational efficiency, which includes a high degree of standardisation. Thus, MNCs are likely to tailor production processes in all of their operations in conformity to those jurisdictions where they operate (which will almost always include one or more of the US, Japan or EU) that has the most rigorous standards. As for labor costs, while MNCs clearly pay workers in, e.g. Vietnam, much less than they would in the US (though it is worth noting that higher American productivity—linked to technology—means that any comparison is tricky, since in America the same company would probably hire far fewer people and automate whatever process they performed in Vietnam with manual labour), it is also the case that they tend to pay a premium of between 10% and 100% on local labor rates.[10] Finally, depending on the nature of the MNC, investment in any country reflects a desire for a long-term return. Costs associated with establishing plant, training workers, etc., can be very high; once established in a jurisdiction, therefore, many MNCs are quite vulnerable to predatory practices such as, e.g., expropriation, sudden contract renegotiation, the arbitrary withdrawal or compulsory purchase of unnecessary 'licenses,' etc. Thus, both the negotiating power of MNCs and the supposed 'race to the bottom' may be overstated, while the substantial benefits that MNCs bring (tax revenues aside) are often understated

Market withdrawal

Because of their size, multinationals can have a significant impact on government policy, primarily through the threat of market withdrawal. For example, in an effort to reduce health care costs, some countries have tried to force pharmaceutical companies to license their patented drugs to local competitors for a very low fee, thereby artificially lowering the price. When faced with that threat, multinational pharmaceutical firms have simply withdrawn from the market, which often leads to limited availability of advanced drugs. In these cases, governments have been forced to back down from their efforts. Similar corporate and government confrontations have occurred when governments tried to force MNCs to make their intellectual property public in an effort to gain technology for local entrepreneurs. When companies are faced with the option of losing a core competitive technological advantage or withdrawing from a national market, they may choose the latter. This withdrawal often causes governments to change policy. Countries that have been the most successful in this type of confrontation with multinational corporations are large countries such as United States and Brazil[citation needed], which have viable indigenous market competitors.

Lobbying

Multinational corporate lobbying is directed at a range of business concerns, from tariff structures to environmental regulations. There is no unified multinational perspective on any of these issues. Companies that have invested heavily in pollution control mechanisms may lobby for very tough environmental standards in an effort to force non-compliant competitors into a weaker position. Corporations lobby tariffs to restrict competition of foreign industries. For every tariff category that one multinational wants to have reduced, there is another multinational that wants the tariff raised. Even within the U.S. auto industry, the fraction of a company's imported components will vary, so some firms favor tighter import restrictions, while others favor looser ones. Says Ely Oliveira, Manager Director of the MCT/IR: This is very serious and is very hard and takes a lot of work for the owner.pk

Multinational corporations such as Wal-mart and McDonald's benefit from government zoning laws, to create barriers to entry.

Many industries such as General Electric and Boeing lobby the government to receive subsidies to preserve their monopoly.

Patents

Many multinational corporations hold patents to prevent competitors from arising. For example, Adidas holds patents on shoe designs, Siemens A.G. holds many patents on equipment and infrastructure and Microsoft benefits from software patents. The pharmaceutical companies lobby international agreements to enforce patent laws on others.

Government power

In addition to efforts by multinational corporations to affect governments, there is much government action intended to affect corporate behavior. The threat of nationalization (forcing a company to sell its local assets to the government or to other local nationals) or changes in local business laws and regulations can limit a multinational's power. These issues become of increasing importance because of the emergence of MNCs in developing countries.

Micro-multinationals

Enabled by Internet based communication tools, a new breed of multinational companies is growing in numbers.(Copeland, Michael V. (2006-06-29). "How startups go global". CNN. http://money.cnn.com/2006/06/28/magazines/business2/startupsgoglobal.biz2/index.htm. Retrieved 2010-05-13.) These multinationals start operating in different countries from the very early stages. These companies are being called micro-multinationals. (Varian, Hal R. (2005-08-25). "Technology Levels the Business Playing Field". The New York Times. http://www.nytimes.com/2005/08/25/business/25scene.html. Retrieved 2010-05-13.) What differentiates micro-multinationals from the large MNCs is the fact that they are small businesses. Some of these micro-multinationals, particularly software development companies, have been hiring employees in multiple countries from the beginning of the Internet era. But more and more micro-multinationals are actively starting to market their products and services in various countries. Internet tools like Google, Yahoo, MSN, Ebay and Amazon make it easier for the micro-multinationals to reach potential customers in other countries.

Service sector micro-multinationals, like Facebook, Alibaba etc. started as dispersed virtual businesses with employees, clients and resources located in various countries. Their rapid growth is a direct result of being able to use the internet, cheaper telephony and lower traveling costs to create unique business opportunities.

Low cost SaaS (Software As A Service) suites make it easier for these companies to operate without a physical office.

Hal Varian, Chief Economist at Google and a professor of information economics at U.C. Berkeley, said in April 2010, "Immigration today, thanks to the Web, means something very different than it used to mean. There's no longer a brain drain but brain circulation. People now doing startups understand what opportunities are available to them around the world and work to harness it from a distance rather than move people from one place to another."

ENVIRONMENTAL ETHICS

Environmental ethics believes in the ethical relationship between human beings and the natural environment. Human beings are a part of the society and so are the other living beings. When we talk about the philosophical principle that guides our life, we often ignore the fact that even plants and animals are a part of our lives. They are an integral part of the environment and hence have a right to be considered a part of the human life. On these lines, it is clear that they should also be associated with our guiding principles as well as our moral and ethical values.

What is Environmental Ethics?

We are cutting down forests for making our homes. We are continuing with an excessive consumption of natural resources. Their excessive use is resulting in their depletion, risking the life of our future generations. Is this ethical? This is the issue that environmental ethics takes up. Scientists like Rachel Carson and the environmentalists who led philosophers to consider the philosophical aspect of environmental problems, pioneered in the development of environmental ethics as a branch of environmental philosophy.

The Earth Day celebration of 1970 was also one of the factors, which led to the development of environmental ethics as a separate field of study. This field received impetus when it was first discussed in the academic journals in North America and Canada. Around the same time, this field also emerged in Australia and Norway. Today, environmental ethics is one of the major concerns of mankind.

When industrial processes lead to destruction of resources, is it not the industry's responsibility to restore the depleted resources? Moreover, can a restored environment make up for the originally natural one? Mining processes hamper the ecology of certain areas; they may result in the disruption of plant and animal life in those areas. Slash and burn techniques are used for clearing the land for agriculture.

Most of the human activities lead to environmental pollution. The overly increasing human population is increasing the human demand for resources like food and shelter. As the population is exceeding the carrying capacity of our planet, natural environments are being used for human inhabitation.

Thus human beings are disturbing the balance in the nature. The harm we, as human beings, are causing to the nature, is coming back to us b resulting in a polluted environment. The depletion of natural resources is endangering our future generations. The imbalance in nature that we have caused is going to disrupt our life as well. But environmental ethics brings about the fact that all the life forms on Earth have a right to live. By destroying the nature, we are depriving these life forms of their right to live. We are going against the true ethical and moral values by disturbing the balance in nature. We are being unethical in treating the plant and animal life forms, which coexist in society.

Human beings have certain duties towards their fellow beings. On similar lines, we have a set of duties towards our environment. Environmental ethics says that we should base our behavior on a set of ethical values that guide our approach towards the other living beings in nature.

Environmental ethics is about including the rights of non-human animals in our ethical and moral values. Even if the human race is considered the primary concern of society, animals and plants are in no way less important. They have a right to get their fair share of existence.

We, the human beings, along with the other forms of life make up our society. We all are a part of the food chain and thus closely associated with each other. We, together form our environment. The conservation of natural resources is not only the need of the day but also our prime duty.

COMPUTER ETHICS

Ethics is a set of moral principles that govern the behavior of a group or individual. Therefore, computer ethics is set of moral principles that regulate the use of computers. Some common issues of computer ethics include intellectual property rights (such as copyrighted electronic content), privacy concerns, and how computers affect society. For example, while it is easy to duplicate copyrighted electronic (or digital) content, computer ethics would suggest that it is wrong to do so without the author's approval. And while it may be possible to access someone's personal information on a computer system, computer ethics would advise that such an action is unethical.

As technology advances, computers continue to have a greater impact on society. Therefore, computer ethics promotes the discussion of how much influence computers should have in areas such as artificial intelligence and human communication. As the world of computers evolves, computer ethics continues to create ethical standards that address new issues raised by new technologies.

WEAPONS DEVELOPMENT

A weapon is an instrument used for the purpose of causing harm or damage to people, animals or structures. Weapons are used in hunting, attack, self-defense, or defense in combat and range from simple implements like clubs and spears to complicated modern machines such as intercontinental ballistic missiles. One who possesses or carries a weapon is said to be armed.

In a broader context weapons include anything used to gain an advantage over an adversary or to place them at a disadvantage. Examples include the use of sieges, tactics, and psychological weapons which reduce the morale of an enemy

Classification

By user

- *what person or unit uses the weapon*

- Personal weapons (or small arms) - designed to be used by a single person.
- Hunting weapon - primarily for hunting game animals for food or sport
- Infantry support weapons - larger than personal weapons, requiring two or more to operate correctly.
- Fortification weapons - mounted in a permanent installation, or used primarily within a fortification.
- Mountain weapons - for use by mountain forces or those operating in difficult terrain.
- Vehicle weapons - to be mounted on any type of military vehicle.
- Railway weapons - designed to be mounted on railway cars, including armored trains.
- Aircraft weapons - carried on and used by some type of aircraft, helicopter, or other aerial vehicle.
- Naval weapons - mounted on ships and submarines.
- Space weapons - are designed to be used in or launched from space.

By function

- *the construction of the weapon and principle of operation*

- Antimatter weapons (theoretical) would combine matter and antimatter to cause a powerful explosion.
- Archery weapons operate by using a tensioned string to launch a projectile.
- Artillery are capable of launching heavy projectiles over long distances.
- Biological weapons spread biological agents, causing disease or infection.
- Chemical weapons, poisoning and causing reactions.
- Energy weapons rely on concentrating forms of energy to attack, such as lasers or sonic attack.
- Explosive weapons use a physical explosion to create blast concussion or spread shrapnel.
- Firearms use a chemical charge to launch projectiles.
- Improvised weapons are common objects, reused as weapons.
- Incendiary weapons cause damage by fire.
- Non-lethal weapons are designed to subdue without killing.
- Magnetic weapons use magnetic fields to propel projectiles, or to focus particle beams.

- Melee weapons operate as physical extensions of the user's body and directly impact their target.
- Missiles are rockets which are guided to their target after launch. (Also a general term for projectile weapons).
- Nuclear weapons use radioactive materials to create nuclear fission and/or nuclear fusion detonations.
- Primitive weapons make little or no use of technological or industrial elements.
- Ranged weapons (unlike Mêlée weapons), target a distant object or person.
- Rockets use chemical propellant to accelerate a projectile
- Suicide weapons exploit the willingness of their operator to not survive the attack.
- Trojan weapons appear on face value to be gifts, though the intent is to in some way to harm the recipient.

By target

- *the type of target the weapon is designed to attack*

- Anti-aircraft weapons target missiles and aerial vehicles in flight.
- Anti-fortification weapons are designed to target enemy installations.
- Anti-personnel weapons are designed to attack people, either individually or in numbers.
- Anti-radiation weapons target sources of electronic radiation, particularly radar emitters.
- Anti-satellite weapons target orbiting satellites.
- Anti-ship weapons target ships and vessels on water.
- Anti-submarine weapons target submarines and other underwater targets.
- Anti-tank weapons are designed to defeat armored targets.
- Area denial weapons target territory, making it unsafe or unsuitable for enemy use or travel.
- Hunting weapons are civilian weapons used to hunt animals.
- Infantry support weapons are designed to attack various threats to infantry units

Consultants are individuals who typically work for themselves but may also be associated with a consulting firm. They, for a fee, gives advice or provides a service in a field of specialized knowledge or training. Most consultants carry their own life and health insurance, pay their own taxes, most have their own tools and equipment. The consultant can work alone or with the client's staff.

Consultants can play a multi-faceted role. They can, for example function as advisors, fixers, bosses, generalists, stabilizers, listeners, advisors, specialists, catalysts, managers or quasi-employees. The actual work that consultants perform for one company to another may vary greatly, i.e. tax account to office decoration. However, the typical underlying reasons that a consultant is hired are universal. A problem exists and the owner or manager of the company has decided to seek the help of an expert.

Bringing in an expert can save time, effort and money. It has been estimated that approximately 3/4 of all companies call upon consultants at one time or another. Many companies claim that they receive a higher return for their invested dollars by using consultants for specific tasks.

Most companies have experienced the problem of needing short-term technical expertise. Perhaps the company's existing staff is already working to capacity. In many cases, the engineering skills required for a project can be satisfied with a full time employee. When they can not fully justify bringing someone on board full time, their answer is to hire a consultant. By doing so, the businessman solves his immediate problem without permanently increasing his payroll and payroll taxes.

Consultants can be hired when the company may not have anyone on staff capable of solving the specific problem. At such times, a costly learning curve on the part of the engineering staff is associated with the project. One example is using a consultant as a viable alternative during the development stages of new products. Hiring a consultant with experience in a given area can then cut days, weeks or even months off a project schedule. In addition, he can help the staff avoid mistakes they may otherwise make. When the project reaches a certain point, the permanent staff can then take over.

Consultants can deal directly with owners and upper management. In this role, consultants can provide an objective third-party view point. Critical objectives can then be identified and advise given in confidence.

Consultants are a viable alternative in assisting in feasibility studies or in proposal preparation.

Perhaps the manager cannot justify shifting the duties of existing staff members.

Another time that consultants become useful is when a company is just starting a business. The development of the company's new product can be begun by the consultant while a full time permanent technical staff member is being hired.

Finding the right consultant can be difficult. Managers can rely on referrals from their friends or hire the consultant who happens to call at the right time. Once the decisions is made to hire a consultant, the need is immediate and one may not have the time to shop for a consultant. As a part of planning ahead, it is wise to meet various consultants on an informal basis before the need to hire one arises. Then when the time comes, you will know exactly who to call for you have already established an informal relationship

ETHICS IN ASCE

To preserve the high ethical standards of the civil engineering profession, the Society's ethics program includes:

- Edict
  The Society maintains a Code of Ethics.
- Enforcement
  The Society enforces the Code by investigating potential violations of the Code and taking disciplinary action if warranted.
- Education
  The Society endeavors to educate its members and the public on ethics issues.

IEEE code of Ethics

1. to accept responsibility in making decisions consistent with the safety, health and welfare of the public, and to disclose promptly 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 this code of ethics

Ethics in Indian Institute of Materials and Management

- To consider first, the TOTAL interest to one's organization in all transactions without impairing the dignity and responsibility to one's office;
- To buy without prejudice, seeking to obtain the maximum ultimate value for each Rupee of Expenditure;
- To subscribe and work for honesty and truth in buying and selling, to denounce all forms and manifestations of commercial bribery and to eschew anti-social practices;
- To accord a prompt and courteous reception so far as conditions will permit, to all who call upon a legitimate business mission;

To respect one's obligations and those of one's organization, consistent with good business practice

Ethics in Institute of Engineers

1.1 Engineers serve all members of the community in enhancing their welfare, health and safety by a creative process utilising the engineers' knowledge, expertise and experience.

1.2 Pursuant to the avowed objectives of The Institution of Engineers (India) as enshrined in the presents of the Royal Charter granted to the Institution, the Council of the Institution prescribed a set of "Professional Conduct Rules" in the year 1944 replacing the same with the "Code of Ethics for Corporate Members" in the year 1954 which was revised in the year 1997.

1.3 In view of globalisation, concern for the environment and the concept of sustainable development, it has been felt that the prevailing "Code of Ethics for Corporate Members" needs review and revision in letter and spirit. The engineering organisations world over have updated their Code of Ethics.

1.4 The Council of the Institution vested with the authority in terms of the Present 2(j) of the Royal Charter adopted at its 626th meeting held on 21.12.2003 at Lucknow the "Code of Ethics for Corporate Members" as provided hereinafter.

1.5 The Code of Ethics is based on broad principles of truth, honesty, justice, trustworthiness, respect and safeguard of human life and welfare, competence and accountability which constitute the moral values every Corporate Member of the Institution must recognize, uphold and abide by.

1.6 This "Code of Ethics for Corporate Members" shall be in force till the same is revised by a decision of the Council of the Institution.

CODE OF ETHICS FOR Institute of Engineers

1.0 Preamble

1.1 The Corporate Members of The Institution of Engineers (India) are committed to promote and practice the profession of engineering for the common good of the community bearing in mind the following concerns :

1.1.1 Concern for ethical standard;

1.1.2 Concern for social justice, social order and human rights;

1.1.3 Concern for protection of the environment;

1.1.4 Concern for sustainable development;

1.1.5 Public safety and tranquility.

2.0 The Tenets of the Code of Ethics

2.1 A Corporate Member shall utilise his knowledge and expertise for the welfare, health and safety of the community without any discrimination for sectional or private interests.

2.2 A Corporate Member shall maintain the honour, integrity and dignity in all his professional actions to be worthy of the trust of the community and the profession.

2.3 A Corporate Member shall act only in the domains of his competence and with diligence, care, sincerity and honesty.

2.4 A Corporate Member 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.

2.5 A Corporate Member shall not falsify or misrepresent his own or his associates' qualifications, experience, etc.

2.6 A Corporate Member, 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.

2.7 A Corporate Member shall maintain utmost honesty and fairness in making statements or giving witness and shall do so on the basis of adequate knowledge.

2.8 A Corporate Member shall not directly or indirectly injure the professional reputation of another member.

2.9 A Corporate Member shall reject any kind of offer that may involve unfair practice or may cause avoidable damage to the ecosystem.

2.10 A Corporate Member shall be concerned about and shall act in the best of his abilities for maintenance of sustainability of the process of development.

2.11 A Corporate Member 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.

3.0 General Guidance

The Tenets of the Code of Ethics are based on the recognition that –

3.1 A common tie exists among the humanity and that The Institution of Engineers (India) derives its value from the people, so that the actions of its Corporate Members should indicate the member's highest regard for equality of opportunity, social justice and fairness;

3.2 The Corporate Members of the Institution hold a privileged position in the community so as to make it a necessity for their not using the position for personal and sectional interests.

4.0 And, as such, a Corporate Member –

4.1 should keep his employer or client fully informed on all matters in respect of his assignment which are likely to lead to a conflict of interest or when, in his judgement, a project will not be viable on the basis of commercial, technical, environmental or any other risks;

4.2 should maintain confidentiality of any information with utmost sincerity unless expressly permitted to disclose such information or unless such permission, if withheld, may adversely affect the welfare, health and safety of the community;

4.3 should neither solicit nor accept financial or other considerations from anyone related to a project or assignment of which he is in the charge;

4.4 should neither pay nor offer direct or indirect inducements to secure work;

4.5 should compete on the basis of merit alone;

4.6 should refrain from inducing a client to breach a contract entered into with another duly appointed engineer;

4.7 should, if asked by the employer or a client, to review the work of another person or organisation, discuss the review with the other person or organisation to arrive at a balanced opinion;

4.8 should make statements or give evidence before a tribunal or a court of law in an objective and accurate manner and express any opinion on the basis of adequate knowledge and competence; and

4.9 should reveal the existence of any interest – pecuniary or otherwise – which may affect the judgement while giving an evidence or making a statement.

5.0 Any decision of the Council as per provisions of the relevant Bye-Laws of the Institution shall be final and binding on all Corporate Members

ASME Code of Ethics of Engineers

ASME requires ethical practice by each of its members and has adopted the following Code of Ethics of Engineers as referenced in the ASME Constitution, Article C2.1.1.

CODE OF ETHICS OF ENGINEERS

The Fundamental Principles

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

I. Using their knowledge and skill for the enhancement of human welfare;
II. Being honest and impartial, and serving with fidelity the public, their employers and clients; and
III. Striving to increase the competence and prestige of the engineering profession.

The Fundamental Canons

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in the areas of their competence.

3. Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall associate only with reputable persons or organizations.
7. Engineers shall issue public statements only in an objective and truthful manner.
8. Engineers shall consider environmental impact in the performance of their professional duties.

The ASME criteria for interpretation of the Canons are guidelines and represent the objectives toward which members of the engineering profession should strive. They are principles which an engineer can reference in specific situations. In addition, they provide interpretive guidance to the ASME Board on Professional Practice and Ethics on the Code of Ethics of Engineers.

1. Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.

   a. Engineers shall recognize that the lives, safety, health and welfare of the general public are dependent upon engineering judgments, decisions and practices incorporated into structures, machines, products, processes and devices.

   b. Engineers shall not approve or seal plans and/or specifications that are not of a design safe to the public health and welfare and in conformity with accepted engineering standards.

   c. Whenever the Engineers' professional judgments are over ruled under circumstances where the safety, health, and welfare of the public are endangered, the Engineers shall inform their clients and/or employers of the possible consequences.

(1) Engineers shall endeavor to provide data such as published standards, test codes, and quality control procedures that will enable the users to understand safe use during life expectancy associated with the designs, products, or systems for which they are responsible.

(2) Engineers shall conduct reviews of the safety and reliability of the designs, products, or systems for which they are responsible before giving their approval to the plans for the design.

(3) Whenever Engineers observe conditions, directly related to their employment, which they believe will endanger public safety or health, they shall inform the proper authority of the situation.

d. If engineers have knowledge of or reason to believe that another person or firm may be in violation of any of the provisions of these Canons, they shall present such information to the proper authority in writing and shall cooperate with the proper authority in furnishing such further information or assistance as may be required.

2. Engineers shall perform services only in areas of their competence.

a. Engineers shall undertake to perform engineering assignments only when qualified by education and/or experience in the specific technical field of engineering involved.

b. Engineers may accept an assignment requiring education and/or experience outside of their own fields of competence, but their services shall be restricted to other phases of the project in which they are qualified. All other phases of such project shall be performed by qualified associates, consultants, or employees.

3. Engineers shall continue their professional development throughout their careers, and should provide opportunities for the professional and ethical development of those engineers under their supervision.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.

a. Engineers shall avoid all known conflicts of interest with their employers or clients and shall promptly inform their employers or clients of any business association, interests, or circumstances which could influence their judgment or the quality of their services.

b. Engineers shall not undertake any assignments which would knowingly create a potential conflict of interest between themselves and their clients or their employers.

c. 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 to, and agreed to, by all interested parties.

d. Engineers shall not solicit or accept financial or other valuable considerations, for specifying products or material or equipment suppliers, without disclosure to their clients or employers.

e. Engineers shall not solicit or accept gratuities, directly or indirectly, from contractors, their agents, or other parties dealing with their clients or employers in connection with work for which they are responsible. Where official public policy or employers' policies tolerate acceptance of modest gratuities or gifts, engineers shall avoid a conflict of interest by complying with appropriate policies and shall avoid the appearance of a conflict of interest.

f. When in public service as members, advisors, or employees of a governmental body or department, Engineers shall not participate in considerations or actions with respect to services provided by them or their organization(s) in private or product engineering practice.

g. Engineers shall not solicit an engineering contract from a governmental body or other entity on which a principal, officer, or employee of their organization serves as a member without disclosing their relationship and removing themselves from any activity of the body which concerns their organization.

h. Engineers working on codes, standards or governmental sanctioned rules and specifications shall exercise careful judgment in their determinations to ensure a balanced viewpoint, and avoid a conflict of interest.

i. When, as a result of their studies, Engineers believe a project(s) will not be successful, they shall so advise their employer or client.

j. Engineers shall treat information coming to them in the course of their assignments as confidential, and shall not use such information as a means of making personal profit if such action is adverse to the interests of their clients, their employers or the public.

(1) They will not disclose confidential information concerning the business affairs or technical processes of any present or former employer or client or bidder under evaluation, without his consent, unless required by law or court order.

(2) They shall not reveal confidential information or finding of any commission or board of which they are members unless required by law or court order

(3) Designs supplied to Engineers by clients shall not be duplicated by the Engineers for others without the express permission of the client(s).

k. Engineers shall act with fairness and justice to all parties when administering a construction (or other) contract.

l. Before undertaking work for others in which Engineers may make improvements, plans, designs, inventions, or other records which may justify seeking copyrights, patents, or proprietary rights, Engineers shall enter into positive agreements regarding the rights of respective parties.

m. Engineers shall admit their own errors when proven wrong and refrain from distorting or altering the facts to justify their mistakes or decisions.

n. Engineers shall not accept professional employment or assignments outside of their regular work without the knowledge of their employers.

o. Engineers shall not attempt to attract an employee from other employers or from the market place by false or misleading representations.

5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.

a. Engineers shall negotiate contracts for professional services on the basis of demonstrated competence and qualifications for the type of professional service required.

b. Engineers shall not request, propose, or accept professional commissions on a contingent basis if, under the circumstances, their professional judgments may be compromised.

c. Engineers shall not falsify or permit misrepresentation of their, or their associates, academic or professional qualification. They shall not misrepresent or exaggerate their degrees of responsibility in or for the subject matter of prior assignments. Brochures or other presentations used to solicit personal employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers, or their accomplishments.

d. Engineers shall prepare articles for the lay or technical press which are only factual. Technical Communications for publication (theses, articles, papers, reports,etc.) which are based on research involving more than one individual (including students and supervising faculty, industrial supervisor/researcher or other co-workers) must recognize all significant contributors. Plagiarism, the act of substantially using another's ideas or written materials without due credit, is unethical. (See Appendix.)

e. Engineers shall not maliciously or falsely, directly or indirectly, injure the professional reputation, prospects, practice or employment of another engineer, nor shall they indiscriminately criticize another's work.

f. Engineers shall not use equipment, supplies, laboratory or office facilities of their employers to carry on outside private practice without consent.

6. Engineers shall associate only with reputable persons or organizations.

a. Engineers shall not knowingly associate with or permit the use of their names or firm names in business ventures by any person or firm which they know, or have reason to believe, are engaging in business or professional practices of a fraudulent or dishonest nature.

b. Engineers shall not use association with non-engineers, corporations, or partnerships to disguise unethical acts.

7. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall endeavor to extend public knowledge, and to prevent misunderstandings of the achievements of engineering.

b. Engineers shall be completely objective and truthful in all professional reports, statements or testimony. They shall include all relevant and pertinent information in such reports, statements or testimony.

c. Engineers, when serving as expert or technical witnesses before any court, commission, or other tribunal, shall express an engineering opinion only when it is founded on their adequate knowledge of the facts in issue, their background of technical competence in the subject matter, and their belief in the accuracy and propriety of their testimony.

d. Engineers shall issue no statements, criticisms, or arguments on engineering matters which are inspired or paid for by an interested party, or parties, unless they preface their comments by identifying themselves, by disclosing the identities of the party or parties on whose behalf they are speaking, and by revealing the existence of any financial interest they may have in matters under discussion.

e. Engineers shall be truthful in explaining their work and merit, and shall avoid any act tending to promote their own interest at the expense of the integrity and honor of the profession or another individual.

8. Engineers shall consider environmental impact in the performance of their professional duties.

a. Engineers shall concern themselves with the impact of their plans and designs on the environment. When the impact is a clear threat to health or safety of the public, then the guidelines for this Canon revert to those of Canon 1.

9. Engineers accepting membership in The American Society of Mechanical Engineers by this action agree to abide by this Society Policy on Ethics and procedures for its implementation.

Moral Leadership

Moral Leadership brings together in one comprehensive volume essays from leading scholars in law, leadership, psychology, political science, and ethics to provide practical, theoretical policy guidance. The authors explore key questions about moral leadership such as:

- How do leaders form, sustain, and transmit moral commitments?
- Under what conditions are those processes most effective?
- What is the impact of ethics officers, codes, training programs, and similar initiatives?
- How do standards and practices vary across context and culture?
- What can we do at the individual, organizational, and societal level to foster moral leadership?

ENGINEERS AS EXPERT WITNESS AND ADVISORS

Engineering expert witnesses are highly credentialed mechanical, safety & civil, geotechnical, chemical and electrical engineers specializing in the areas of design, construction & structural engineering, failure analysis, human factors, occupational safety, metallurgy and more. They provide litigation support through review and evaluation of distressed structures for land slide and erosion cases; performance of forensic studies on hydraulics, power plants, pipelines, boiler systems, traffic, automotive, electrical fire involving electrical systems of machinery; site research and inspection, laboratory testings, report writing, depositions and court testimony.

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