Ethics in Engineering Practice
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Lecture - 24
Engineering as Social Experimentation

Welcome. In today's session, we are going to discuss on how Engineering is like a Social Experimentation.

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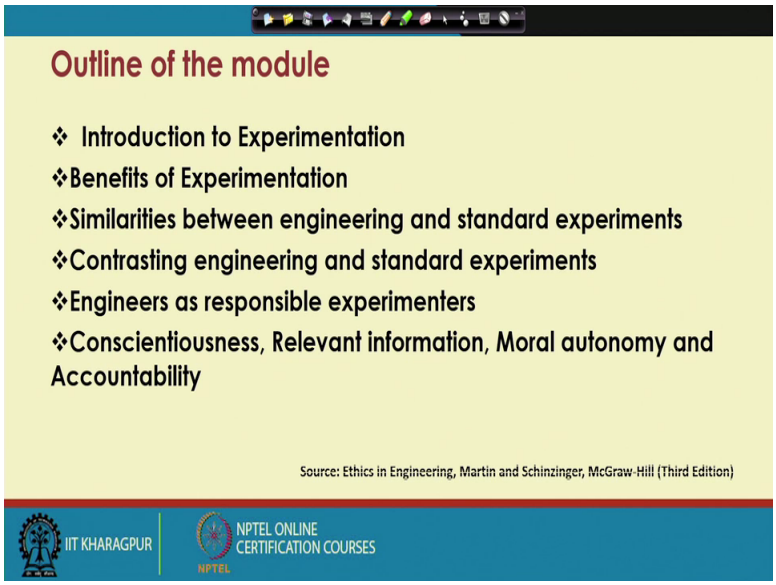

In this module, we are going to discuss about what is experimentation, benefits of experimentation, similarities between engineering and standard experiments, contrasting engineering and standard experiments, engineers as responsible experimenters, conscientiousness, relevant information, moral autonomy and accountability.

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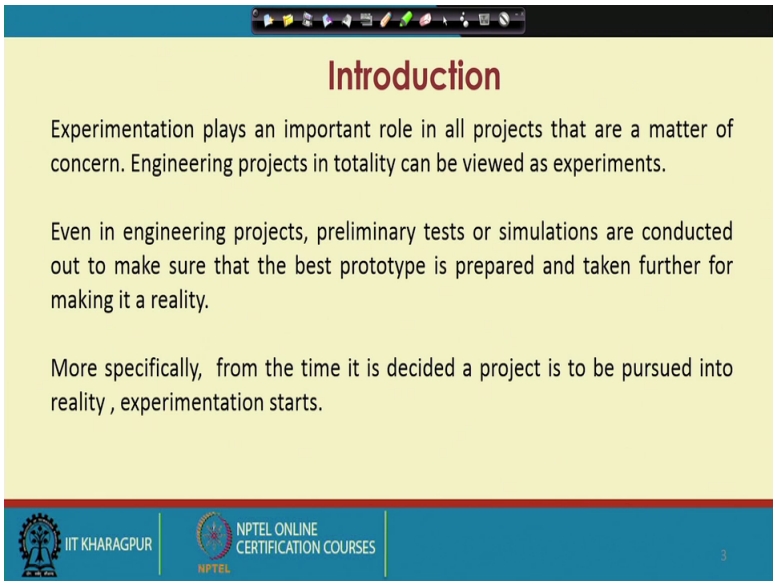

So, what we see is like when we talk of experimentation, experimentation is a very important part for all things like projects which are and it is a matter of concern in the sense because we need to follow certain principles while we are doing experimentations. Engineering projects as it can be viewed as a total, as totality as an experiment. What stand the why it can be considered any engineering projects can be viewed as an experiment in totality is like or in engineering projects also. In many cases, preliminary test and simulations are conducted out to make sure that the best prototype is prepared and before it is taken further to making it a reality.

So, like in science we do experiments in labs situations in a simulated conditions may be in a controlled conditions to find out what is the cause and effect happening like and what are the reactions maybe in chemicals happening to and find out what are the precautions needs to be taken before it is done in a large scale. So, similarly in engineering projects also like preliminary test or some relations are conducted to make sure like the best prototype is prepared because, in engineering what we need to keep in mind like the safety and health issues of the beneficiaries are like one of the major responsibilities of the engineers.

So, without testing something preliminary when doing a like pilot ram of it, we cannot launch a product in a mass scale or try to do something in a mass scale because, in that case the hazards will be, because in that case the hazards will be multiplied manifold if

something wrong happens. So, in that sense more specifically from the time, it is decided the project is to be pursued into reality actually experimentation starts for engineering.

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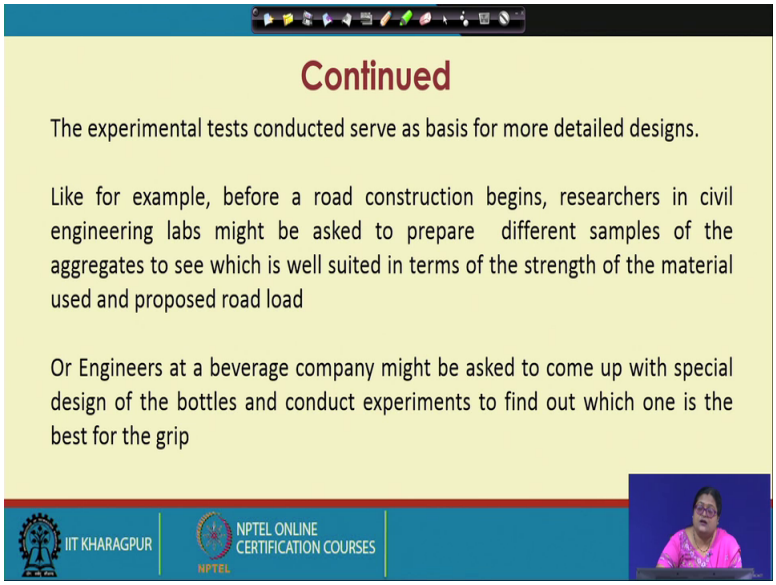

So, the experimental tests that are conducted serve as a basis for more detailed design. So, what we can understand like it is a sort of like ongoing process. We do something maybe we find certain mistakes have been done or something is not working according to our plan, then we need to change it, retest it and finally, after lot of many of iterations generally we come to the end product or designs.

So, like an example before a road construction begins, researches in civil engineering labs might be asked to prepare different samples of the aggregates to see which is well suited in terms of the strength of the material used and the proposed road load. So, here can be other variables you can go on adding more variables to it, may be the weather conditions or maybe the geographical train through which the road is there. So, may be you need to experiment on like the different materials and their aggregate which is going to work better in which situation, which weather condition and may be also this may change due to based on the traffic load and so many other variables that we may think of.

Like all engineers of a like beverage company might be asked to come up with the special design of bottles and conduct experiments to find out like which is one for the best grip. So, what is the shape of the bottle, how it lead to a grip and also, we may add more finer variables to it like who are the potential users maybe whether kids for kids

whether it is for a water bottle, whether something separation should be there or not whether the cap should have a lock or not. So, these kind of thoughts like which occur at the back of designing of bottle, so bring in new changes in the design which is we think of while designing bottles and may lead to like different set of experiments to come up with the best possible design.

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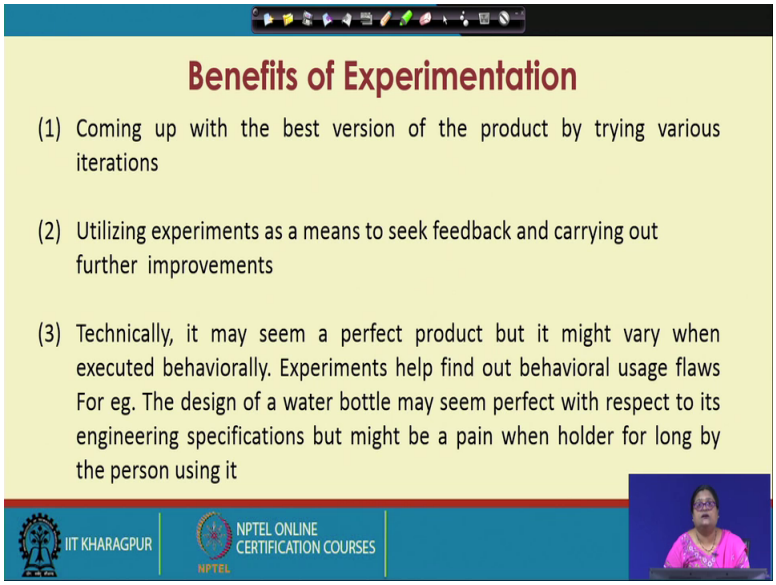

Now, what are the benefits of experimentation? So, one of the first benefit that we can understand is coming up with the best version of the product by trying on various iterations utilising experiments as a means to say feedback and carrying out further improvements. Technically it may seem a perfect product, but it might vary when executed behaviourally.

Experiments help us to find out behavioural usage flaws. For example, the design of water bottle may seem to be perfect with respect to its engineering specifications, but might be a pain when the holder it is for long by the person using it. So, somebody when holds it is for long may be having certain problems with it.

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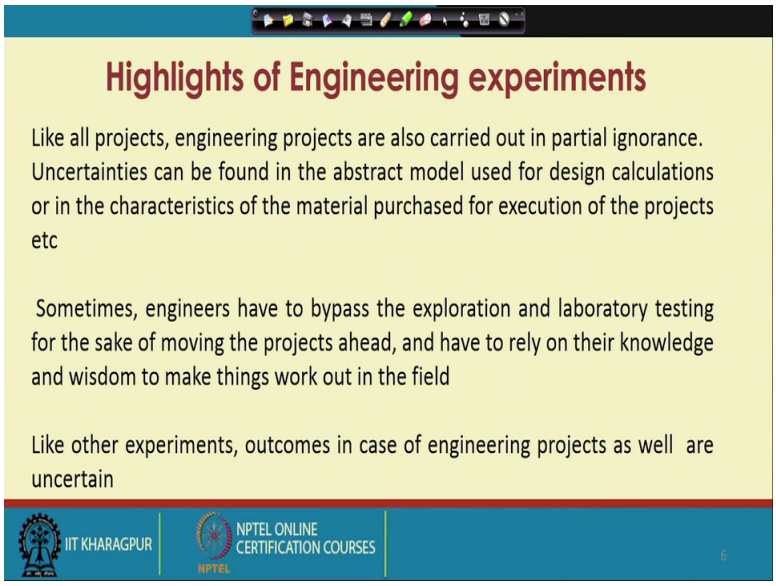

So, otherwise it may be sound, but here we will come to a decisional dilemma where ethics scripts in over here like why we are discussing it under the domains of engineering ethics and. Forest is the case like what we put into the primary focus over here and of course, like and the care and a caring aspect for the beneficiaries. Second is if there is a like conflict of interest happening like you have thought of certain design but when it which may be according to you is experimental sound, but may it may so happen like when the beneficiaries are telling, then you find like you are getting reports of not like it is not suiting their purpose.

Then should you like it is maybe you have the right to explain your design and see it is getting done, but when it is a concern for their beneficiaries may be it is a caring aspect which is more important and you need to have may be a re-look into do what you do and it is where your duty to relook comes in, so that you can answer better to the needs of your beneficiaries. Also when it comes to towards like because we understand, however you are designing what is the material that you are using and what is the outcome and what would be the possible side effects of your experiments or the products or the design that you are doing. Probability is there with you, but the ultimate beneficiaries do not come to know about it.

So, always there is an information asymmetry between what you know and what the others who will be ultimately using it know because it may not be possible for them to

understand what is the mixing that you are doing, what you are thinking because the design is there with you. So, in that case it becomes really very important to understand your values and to be dutiful to checking each and every of the steps to see in proactive in seeing like whether you are using the correct material, whether you are compromising on the safety or not whether you are compromising on the health issues or not because whatever you give to the beneficiaries, they may be accepting it with the total based on the total trust that they may have on you. So, in that case it is a part of the duty and responsibility of the engineers to see like they are not playing with the trust of the public in general.

So, in these aspects how to take care of the design flaws, to what extent you need to be careful, to what extent you need to be very specific to find out like errors are not there? So, what is the extent of it and you may say like it is much deeper into the fact because the knowledge lies with you. What you want to get is an outcome lies with you and there the public at large will have a trust on you and for that you owe to them this like this part is called due care. You need to take due care and responsibility for the safety and security of the public at large and you cannot compromise on these issues and you need to be extremely careful at each of the steps of your experiments to find out.

What would be the possible sources or error which we have noted maybe till presently which you have not noted, but you need to like maybe extend your imagination to find out like what could be the possible misuses and what error it may lead to and whether to you design you can arrest those things like and the proactively instead of waiting and be on a reactive more to find out let us some incident happened and from that incident, we are going to learn and then going to take some remedial measures of it.

So, continuing the discussion we see like for all engine projects, engineering projects are also carried out in partial ignorance. So, uncertainty is there at every step. So, in abstract models used for design calculations or in the characteristics of the material purchased and for execution of the projects extra because there is so much of uncertainties and risk involved and because we are responsible for the safety and security and health issues of the public at large, .engineers need to be extremely careful and duty conscious for while executing each of the steps of a particular project for experiment.

Sometimes engineers have to bypass exploration and laboratory testing for the sake of moving the projects ahead and to have to rely on their knowledge and wisdom to make things work out in the field, but again this is this could be a conflict of interest like seeing your own, getting your own individual interest or may be your companies interest and it is a interest of the public at large.

You have to question yourself for what is the seriousness and urgency of your project and what is the ultimate like outcome it may be there, what is the degree of harm that may be done if you are by passing the important steps of exploration and laboratory testing. Just for the sake of moving the projects ahead can you compromise on these things and what is the if you are compromising, what is the extent of harm that you are looking forward to and what will be the spread of that? Can you really compromise on these things or not? For this short term outcome which mean short term gain which may lead to a long term disaster. So, can you really do it or not because it is an uncertainty and how much you can rely on your knowledge and wisdom, have you tested for everything, have you rationally justified for everything? So, these are the questions that we need to ask ourselves.

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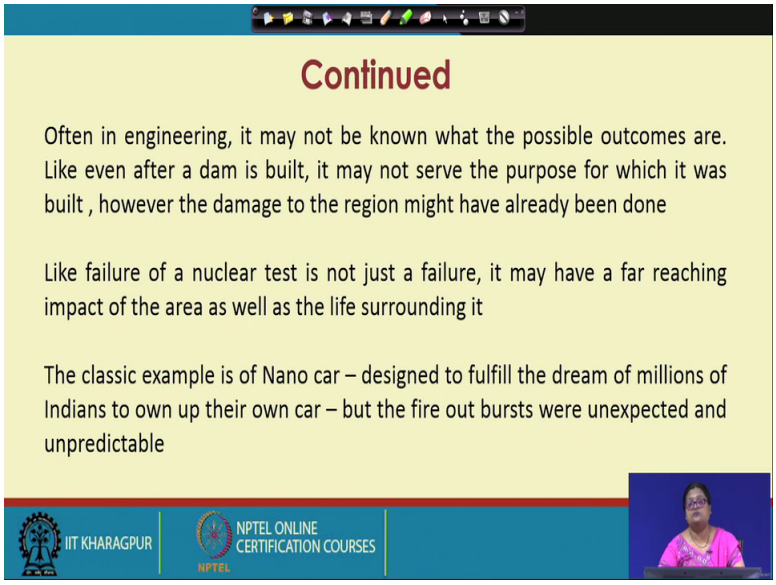

So, what happens often in engineering, it is not known what the possible outcomes are like even after a dam is built; it may not serve the purpose for which it was built. However, the damage that is done to a region has already been done. So, it is very

important to look at this from the utilitarian perspective rights and duties perspective, justice perspective and of course, caring perspective to find out the pros and cons of the action and long term after effect of in terms of the harm provided as the consequence of our action and whether that really justifies our action or not.

So, like failure of a nuclear test is not just a failure, it may have for reaching impact of the area as well as in the life surrounding it. So, in the future when we will have the case discussion sessions, we will discuss more in details about it from the cases, but these are certain like whether we can really do it and can we be casual about not doing a laboratory test or not doing a proper survey to find out to what could be the degree of risk involved or not. If our experiment is going to fail, if everything is not going to work properly, then what is going to happen? Can we really compromise on that part or not?

The classic example is of the nano car which is designed to fulfil the dreams of millions, but sometimes what happens for out bursts or unexpected and unpredictable. So, what can be done in that be in the effort to provide a low priced car, what are the things that we can really compromise on. Can we compromise on the safety aspect of the car to make it a low price? So, these are questions that we need to answer.

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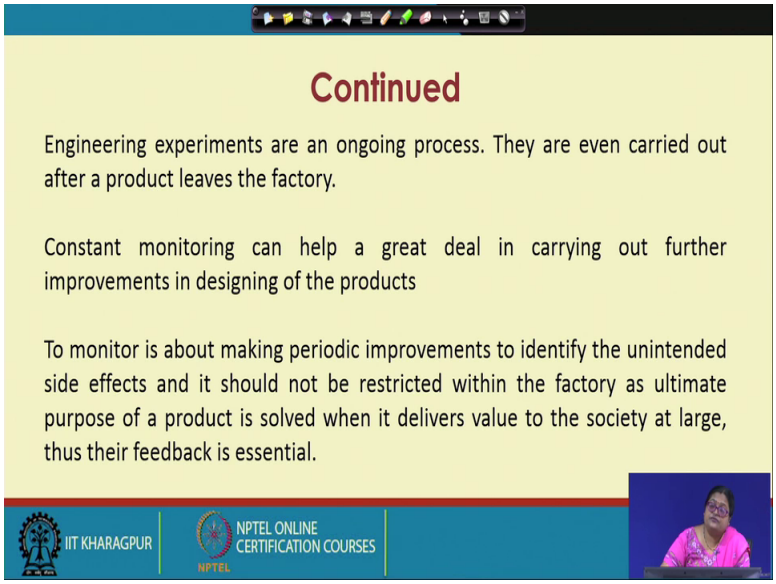

So, what we understand we have to understand like engineering experiments are ongoing process. It continues even after the product leaves the factory because once it reaches the beneficiaries, you do not know like how they are going to use it and what could be the

after shelfs like problems coming up where they will need services from you, what will be the nature of problem and where there you need to modify your design or not to take care of those problems in future time. So, this is an ongoing process and it never stops after the factory product leaves the factory, but is continuous after that also.

So, constant monitoring and this can be done through constant monitoring which can help to great deal in carrying out further improvements in designing the products. To monitor is to is about making periodic improvements to identify the unintended side effects and it should not be restricted with the factories. Ultimate purpose of the product is to solve when it delivers values to the society at large. So, their feedback is essential.

So, how you improve your supply chain, how you connect to your customers and get a feedback from them, how you incorporate that feedback and improve on your design like how much importance and weightage do you give to that feedback and do are you open to like if a negative feedback are not and what you do about it these are also ethical questions that you need to ponder upon.

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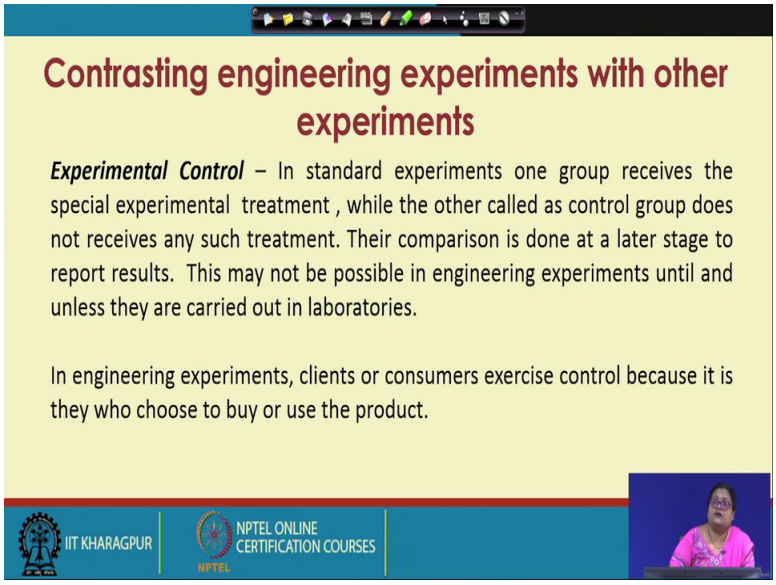

So, if you are trying to contrast engineering experiments with other experiments, what we find here is that in standard experiments one group receives the special experimental treatment while the other is called a control group does not receive any such treatment. The comparison is done at a later stage to report results. This may not be possible in

engineering experiments until and unless they are carried out in laboratory. So, you in many cases you may or may not have a totally in controlled situation.

So, in engineering experiments clients or consumers exercise control because it is they who choose to buy or to use the products. So, which product will be seeing the repeat cycle of getting produced again depends in many cases on whether it is being bought by the a greatest society at large or not. So, people if is the end users are not interested in a maybe you do not go on for producing it. So, they actually it is they who are exercising the control on the products.

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So, another thing which is important for engineering products which is very important today for any kind of research also it is a all for informed consent testing drugs. So, in case of pharmaceutical research and all is cannot be done on human until and unless their consent is taken.

So, for in medical experiments, it is very important like the people give their because the safety issues are there. It is important that they give their free will to participate in medical experiments and they are aware of it of the maybe the side effects and other things. So, it involves two things; knowledge and voluntariness.

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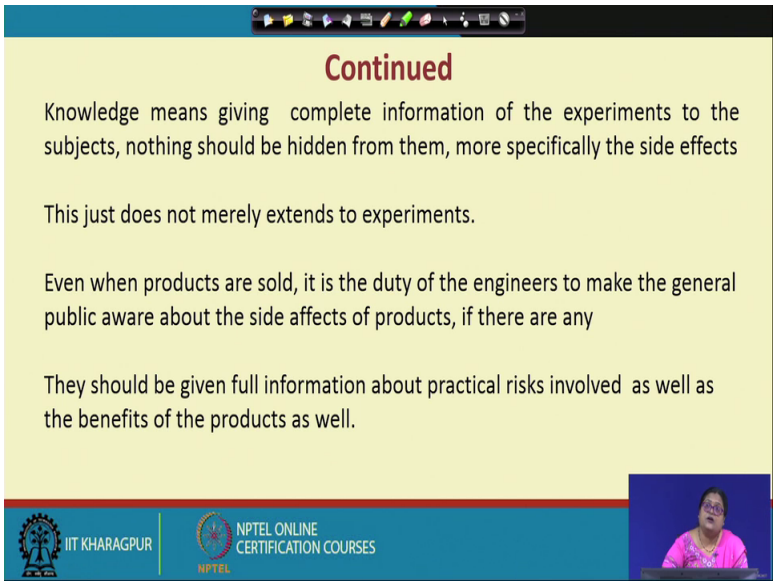

So, when you are talking of informed consent and knowledge, we are talking of the knowledge of the maybe giving awareness to the person in terms of sharing information to the subjects where nothing should be hidden from them, more specifically the side effects. So, this not only is restricted to experiments, it holds equally good for products also. So, it is the duty of the engineers to make people aware of the side effects of the products if there are any. They should be given full information about risk involved and the benefits of the product.

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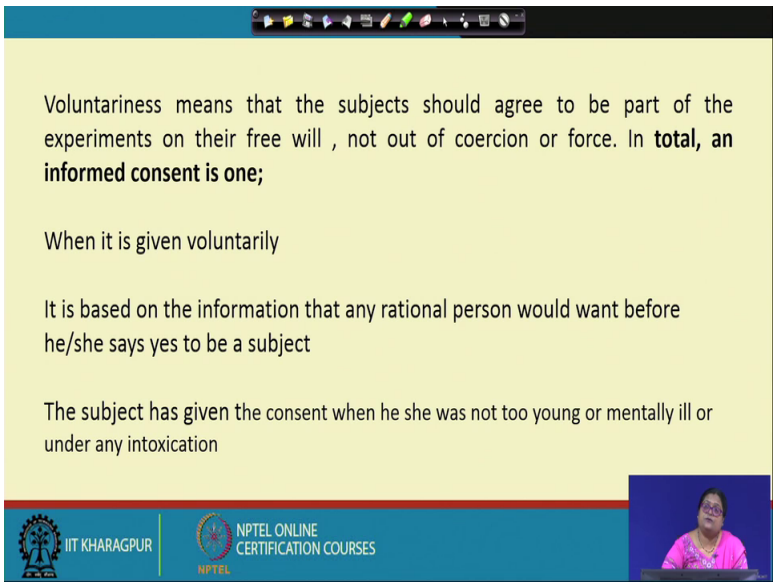

Voluntarily voluntariness means that the subject should agree to be a part of the experiments at their free will, not by coercion or a force. So, it is like after knowing the side effects, after knowing maybe the whole process of how the experiment is carried out, they should be consenting on their own on their free will. They should not be doing it under coercion or force. In totality these two characteristics of knowledge awareness and informed consent together makes the knowledge and voluntariness together makes the informed consent.

So, when a consent is given voluntarily, it is very definitely required like every information is shared with the rational person and before he says yes as a subject and the person who has given the consent, it needs to be checked like that person is not too young or not under intoxication or not mentally ill means the person has given the consent is a rational person who has a rational sense of discriminating between what is good, what is bad what is right and what is wrong and can make a informed decision were informed decision and after the decision is being made, he or she has given the consent for their research.

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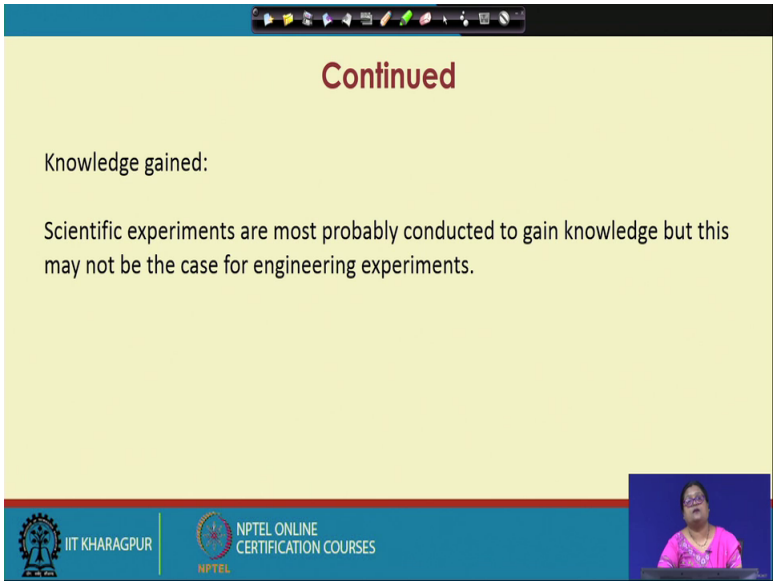

So, not in terms of knowledge gained, scientific experiments are most probably conducted to gain knowledge, but this may not be the case of engineering experiments because engineering in its engineering experiments there are so much of uncertainty is involved and it is an ongoing process where at every step the outcome gives the feedback

based on what is the changes in processes needs to be made. We need to be prepared for unexpected results and we need to make our plans accordingly if some unexpected things are happening. What we are learning from them, so that we can correct on our plans that we have made and relook at the design, so that these problems gets arrested.

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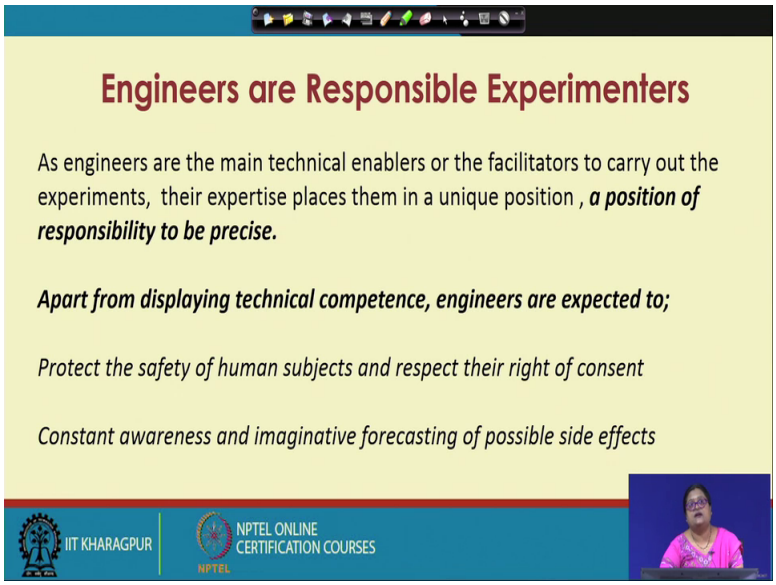

That is why what we are discussing now is that of engineers as responsible experimenters; so, as engineers are the main technical enablers or facility to carry out the experiments, their expertise puts them in a unique position of responsibility. So, position of responsibility apart from displaying technical competence, engineers are expected to protect the safety of human subjects and respect their right of consent, constant awareness and imaginative forecasting of side possible side effects.

So, we have to extend our ethical imagination and to find out what could be the possible harms even if you are not being able to understand at present, what could be the, how to connect the unconnected parts and to find out what could be the possible harms done in future and how whether we can take care of it at the design part itself or like what are the ingredients you are put into the product or not, what could be the long term effect of those things.

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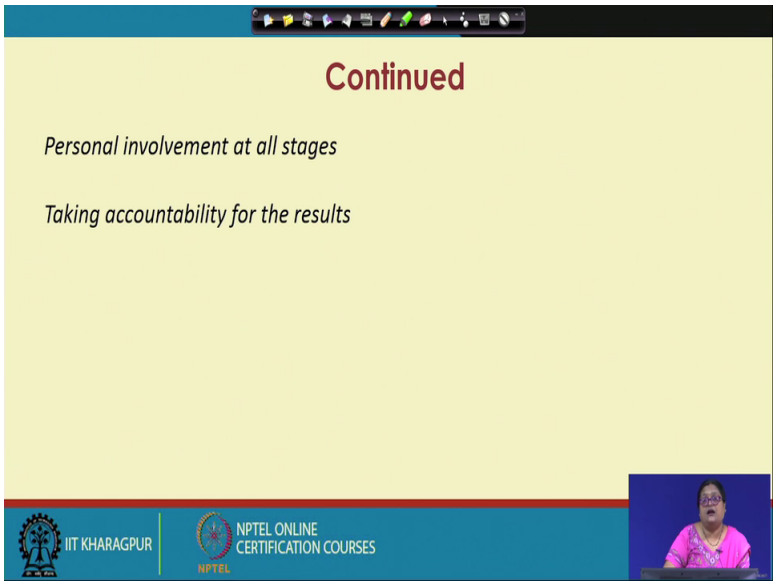

So, it requires actually personal involvement at all stages, taking ownership of the experiment, thinking at it is very close to oneself and monitoring it and taking accountability of the results.

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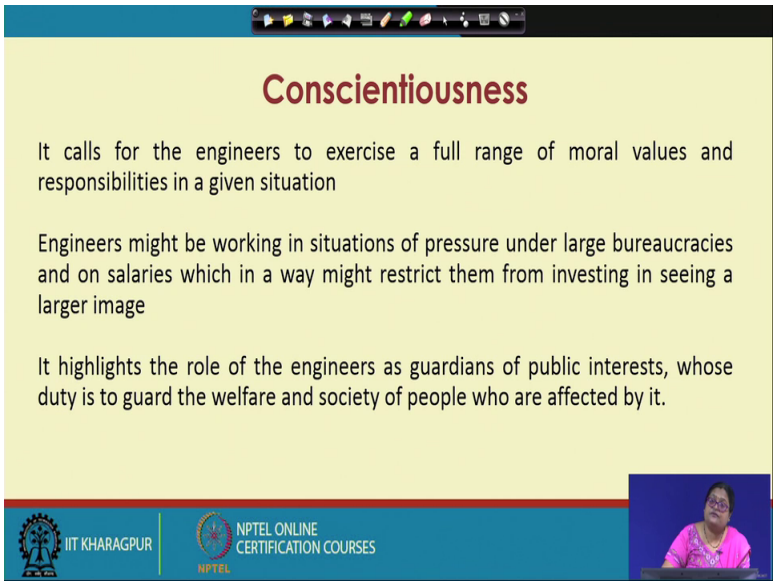

When we talking of consciousness, it talks of the it calls for engineers to exercise a full range of moral values and responsibilities in a given situation. So, engineers must maybe working in situations under large bureaucracies in situations of pressure and then, salaries which may restrict them to see the larger picture, but again what are your virtues,

what are your values which are guiding you because you are actually the person who is responsible for the interest of the public at large, public who trust you, who depend on you and it is a duty for you to respect their trust. So, because you are the guardian of the welfare and society welfare of the society and the society of people at large, can you compromise that grow large when you say no to that crowd and then, if you realise your duties then what are the actions that you need to take.

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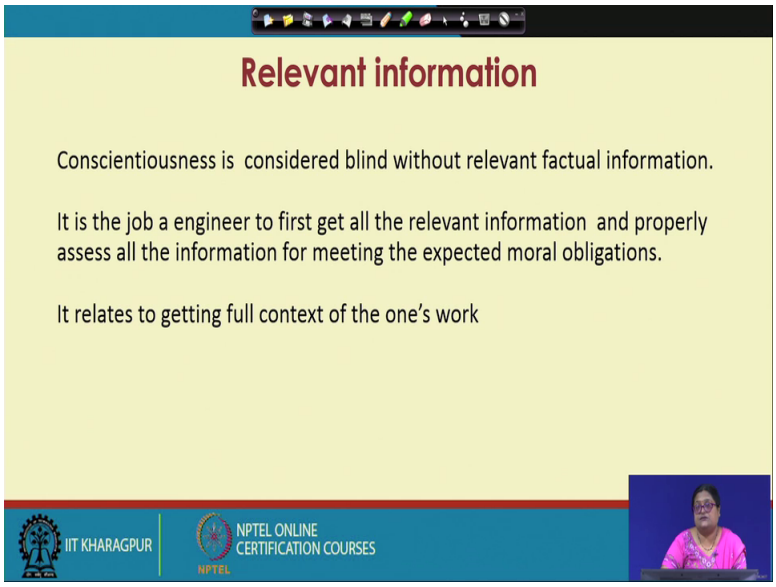

So, when you talking of consciousness, when you are talking of agreeing to certain things, it is considered to be blind without relevant factual information. So, it is the job of an engineer to first find out relevant information and then, properly access all the information for meeting the expected moral obligation. It relates to getting the full context of one's work. You have to need to explore all the possibilities, you have to extend your imaginative thought process to find out if something even is not appearing to be harmful at present, can it in the long term effect the safety and health of the public at large.

So, if that is so then should we may be use this ingredient, not used ingredient if you feel like it is important to what extent you should use it and should we make the public aware of the possible side effects or not or a series of questions that you need to answer to yourself and share it with your beneficiaries at large, so that they can take an informed decision of their choices.

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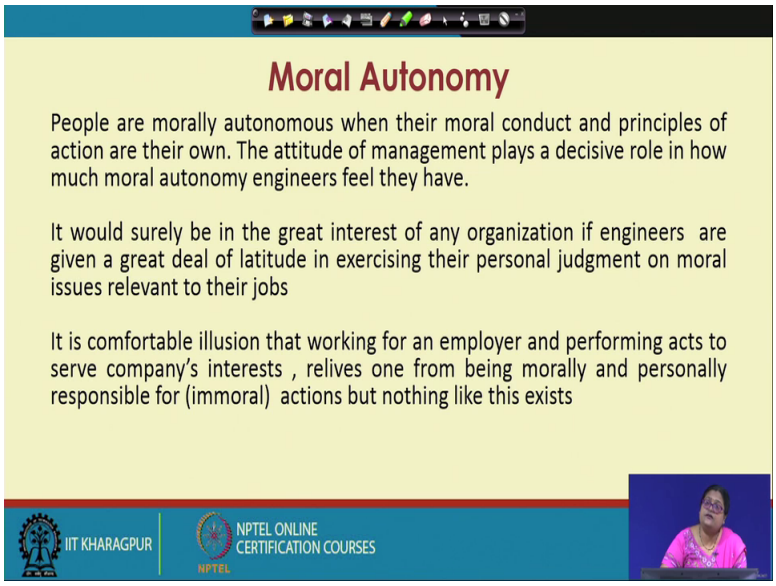

So, when we are talking of moral autonomy, it is people are morally autonomous. When the moral conduct and principles of action are their own, the attitude of management plays a decisive role in how much moral autonomy the engineers feel they have. It will be a great interest of any organisation if engineers are given a great degree of latitude in exercising their personal judgement in moral issues relevant to their job.

So, we may tell like we are working for the employer and we need to take the employers interest first, but if we have, but this is where our professional ethics helps us to answer this dilemma. As an engineer, we do have a we have taken a professional oath, we have of the profession itself guides us towards certain values and gives us certain roles and in that the safety and security health and a welfare of the people at large are major responsibilities to look after these factors and major responsibilities of engineers.

So, we just cannot tell like we are working for a company and we have to be loyal to their interest first, but if you find like what they are doing is coming in conflict with this other responsibility that we have. So, the responsibility towards the safety and security of the society at large is one of the primary responsibility and if required, our professional ethics guides us to voice for the life practices done by your company and we can always ask to them to change or have a relook into the processes, so that we are not compromising on the safety and security of the public at large.

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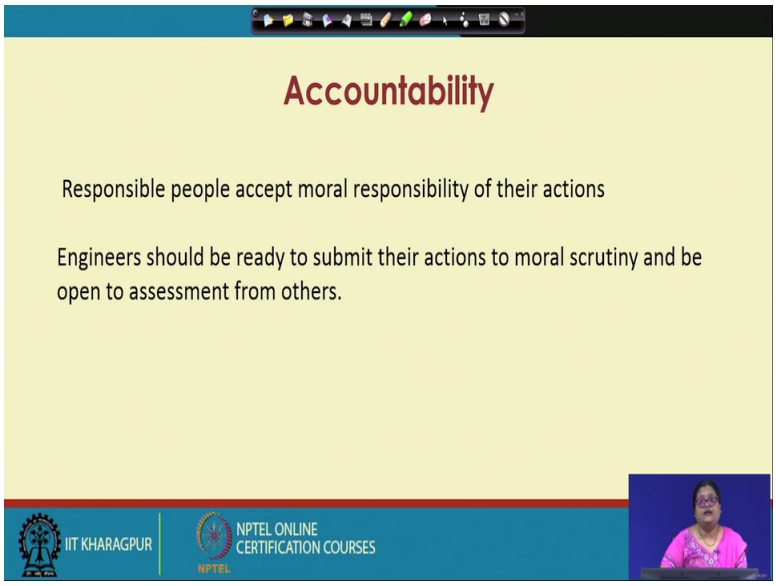

So, there comes the question of accountability. Responsible people must accept moral responsibility of their actions. Engineers should be ready to submit their actions to model scrutiny and be open to assessment from others. So, we should be open enough because there are so much of uncertainty is involved in each step of the design and ways of executing it. Engineer should be ready to submit their actions to moral scrutiny and take a proper feedback from others and work on those feedbacks to have a relook into the design and ways of doing things.

Because, ultimately what is their role and responsibility is towards the welfare of the public at large and there is what we cannot something which you cannot compromise with. And, for that we should be open to suggestion, open to critical comments to maybe modify the ways that we are thinking, the ways that we are doing the experiments, the outcomes that you are having, the way that the experiments are designed.

So, that have been taken care of all the possible hazards that would be happening. Have we tested for them and have you seen the outcome or we have tried to just look into something which gives us the favourable result as expected. Have we explored for the unexpected results and the reasons for it and try to take care of it by again doing experiments to find out why this thing happened, why something happened which was not expected. What is the reason behind it, where it went wrong and again doing some recheck revaluating of it and coming back through these processes of iteration to reduce

the risk, reduce the harm and emerge as a design which comes up to be the best design for the thing that we are trying to give to the beneficiaries in a large scale.

Thank you.