Bulk Material Transport and Handling System
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology – Kharagpur

Lecture – 58
Basic Introduction of Automatic Control

Welcome back students we are almost nearing to the end of our last module that only two three classes are left. So, today we will be discussing something important about this automation and automatic control. You know that this bulk material handling operations these are it involves a quite a wide range of operations and we have not in our whole deliberations we have just introduced some part of it.

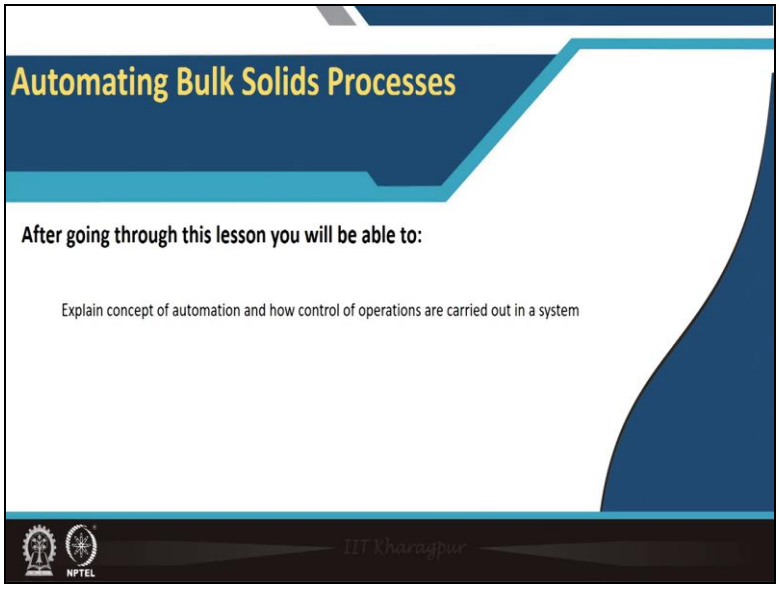
Many of the things we could not because there are lot of other things involved but one thing is very important for you to make a note that the today the whole operations are well mechanized. Now that all our bulk material handling and transportation system it introduces very high capacity machines and a very costly equipment. Now there when you are operating at that time you need to keep a very constant vigilant.

That means if the system is not properly attended and their actions are initiated then there could be a big loss and in safety in your productivity as well as your economic loss that is why it is very important that we need to properly monitor and control. Now for controlling as you see if as a human person by its perseverance and observation need to control there may be some response lapse.

So, because if a person is to say a machine is to be stopped at a particular deviations from the normalcy at that time he will have to first observe somewhere an enunciation panel or a signal coming from that particular one. And then after observing it when he will be just putting the putting his hand for switching it off at that time there may be a sufficient damage to the system. That is why all modern systems they have gotten automatic control.

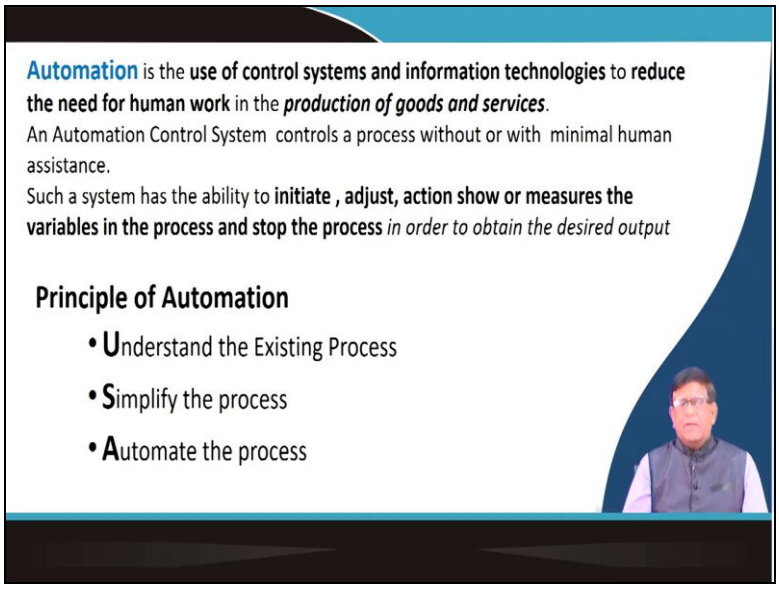
Then there is a certain level of automation that means the things are even if the person is not there the operations and their safety management maintaining it will not be any problem.

(Refer Slide Time: 03:00)



So, that is the basic objective of this automation and automatic control or automating the bulk solid processes. The bulk solids processes means its handling processes its transporting systems in that today we will be discussing some issues that you will be able to explain the concept of automation and how control of operations are carried out in our bulk material handling system.

(Refer Slide Time: 03:29)



So, this introductory note will be defining automation how can you define it. Automation is the use of control systems that is when you use certain things to control means when you need to start when you need to stop when you make to slow it down that control system that automation is the use of control systems and information technology you will be controlling when certain information from the system is with you that whether it is ok or not.

So, why do you do this automation to reduce the needs for human work in the production of goods and services whatever with the deliverable of your material handling and transportation systems in that automation is the use of the control systems and information technology to reduce the need for human work. Now an automation or automatic control system or an automated control system it controls processes without or which minimal human assistance.

Many of the control systems they may have the human interference or without such a system has the ability to initiate adjust the actions to show or measure the variables in the processes and stop the process when it is required. So, that the desired output is achieved. Now as a principle of automation you will see that it has got two things the three things mainly which is an abbreviation you can tell it as a USA that is to understand the existing process.

This is very important how what is going on in the system must be properly understood. Now how do we understand we understand by our senses as by seeing by hearing by testing by touching or by testing we understand about our surrounding how it is there. So, that to understand the processes in any automation we will require some sensors and the sensors is a that itself is another worst subject but you will find out.

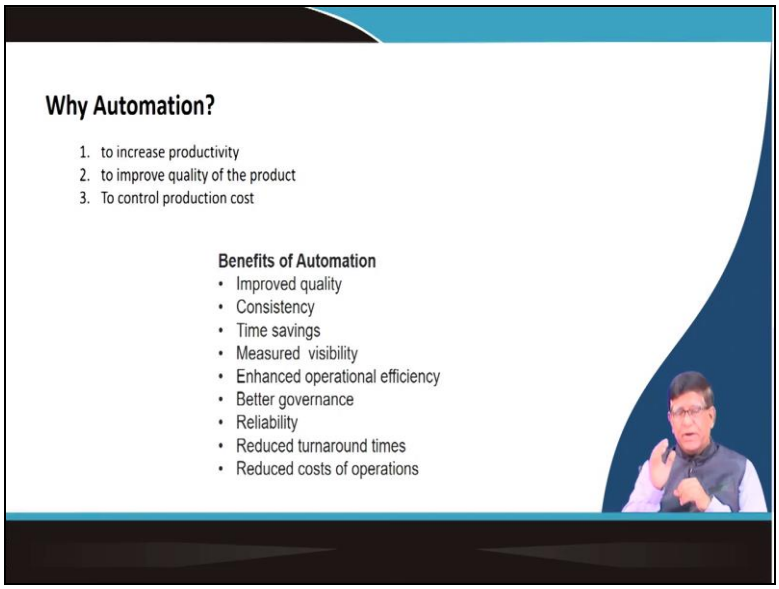
In your the material handling cases you will have to sense many parameters like what is the temperature what is the vibration level what is the speed what is exactly time passing through this then your weather that what type of noise is coming from. So, those things when you will be sensing it will give you the understanding of the system whether it is normally working or it is deviating. Then you will have to simplify the process one thing is there your in any automation we should not make the things complicated.

So, many controls, so, many things, so, many variables no you will have to see that what is the simplest way of doing the things once you know that then only you can make a most effective automation and then automate the process. Main thing is that that means without any human interference or with a minimal interference the process the work is going on process means it is an integration of number of activities.

In any process you will find out there are many unit operations and that each unit operations may be having some number of components basic things what you will see there will be certain powered motions or there are certain activities where you are exactly dissipating

energy. Wherever this energy is involved that means there is some process is going on some activity is going on that you will have to identify and there you will have to derive the information's for doing the automation.

(Refer Slide Time: 07:45)



Now why we need such automation say for example if you are thinking of a silo in you have studied about the silo bin and bunker a silo may be at a 30 meter or 40 meter height silo at that time there your conveyor belt is feeding the material to the silo you remember the silo operations you know. Now at that time if that your there is a some problem in that from the silo material is unloaded to a say train and the wagons are being filled but suppose your wagons have not come but your production system their conveyor the material is coming at that time silo storage will be coming up.

Now if you do not stop the conveyor belt at that time it will get over spill the whole around everything will get destroyed. So, this will be this is an example that you cannot go and climb over there while it is going on or it is not always safe to keep a person just at the point to watch what is that how much it is getting filled. But if you can sense the things what is going on inside and then you can automatically give signal to the production system that no that our wagon is not coming we cannot and let us transfer the material from silo to the train.

So, please stop it there. So, what will have to do otherwise you will have to take a phone call to this operator to that operator but here we can automate by that what will happen your energy which are going to be unnecessarily wasted that energy will be saved and when

energy is saved exactly money is saved and money is saved means total production per unit cost is improving means you are improving the productivity.

So, automation it increases the productivity many a time by controlling the operations properly by maintaining the output throughput capacity that keep maintaining the your ingredients for producing that material it is control properly. So, your productivity increases and then it can improve the quality. Because suppose you are doing a crushing, crushing you know the jaw crusher the crossing is going on taking place.

But you do not know that if the jaw crusher's jaw has all worn out and the gap has increased. So, your larger particles will be going to the next phase and again maybe your that that your feeding back that oversize's will be again coming to the crusher to get it crushed again. So, now what is happening if you monitor that is if you automate that to see that what is the size going or what is the gap is maintaining at the proper things if you monitor it and then give a control that now the gap is increasing.

By monitoring that you can automate that means if there is a large boulder is coming to the output size you need to adjust the gap so, that the next time that only the minimum size will be going. So, by that you are maintaining the quality at the same time you have automated or you can sometimes automatically without manual you can develop a system. So, that the gap will be self adjustable and then as I said already it will increase the production cost.

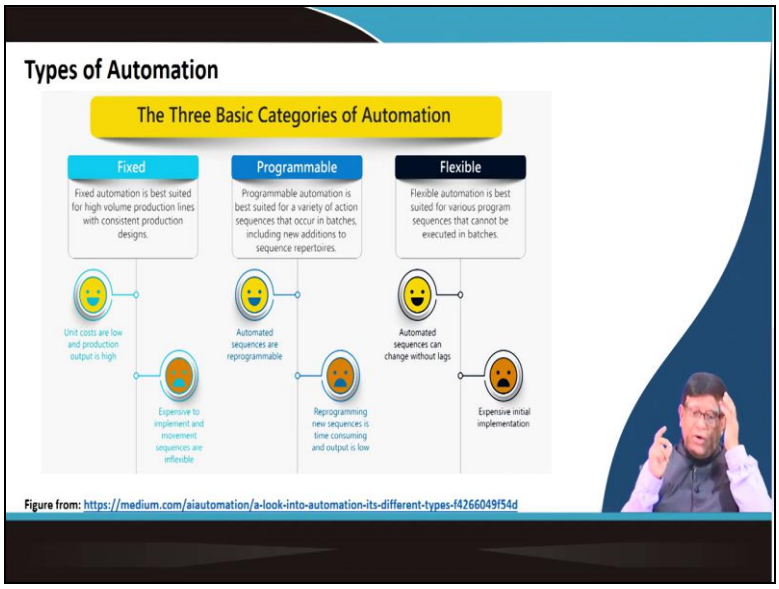
So, I think it is clear to you that automation is a need it is not that sometime people used to say that this by automation you will be reducing the manpower yes we can we reduce the manpower for increasing productivity that does mean that these human resources which will be getting rid of some repetitive poor quality job they can be employed they can be trained they can be made use in other purposes.

So, that the overall they also get their livelihood and all. So, there is a sociopolitical aspect of automation is there that is a different issue you can you can study that thing separately. But you must know that the benefits of automation in bulk material handling can give you improved quality it will give a consistency that is you whatever you have committed to deliver that you consistently provide there is a time saving you will not be wasting time that is also how it will be contributing to the productivity.

A major visibility everything is very transparently known to you that this is happening and the enhanced operational efficiency will be coming then better governance you can manage the things better way. So, you are ultimately all engineers when you will be growing in your career you will be a technology manager. And in the technology management your this automated systems will allow you empower you to get better governance reliability of your services.

And the product could be maintained reduced turnaround time the cycle time in any transportation systems you can easily this reduce the cycle time by certain degree of automation and overall it will reduce the whole cost of your operation. So, I think you know now the basic things why we need to go for automation.

(Refer Slide Time: 13:20)



Now, these automations how it could be there, there are different type of degree of automation depending on the work where you are going for doing this automation. Now there is a something called your fixed automation which is exactly wherever there is a high production lines with a consistent production design there we can go a fixed type of where their unit costs are low and the production output is high.

And there your expensive to implement and movement sequences are inflexible that is a very rigid fix you do not have much control it will do this only whatever has been assigned. So, that is a fixed type of automation and there is a programmable, programmable means you have got certain degree of control that what you want to do that you can apply this

programmable automation in the for a variety of action sequences that means whatever is there you just program it accordingly it will give the services.

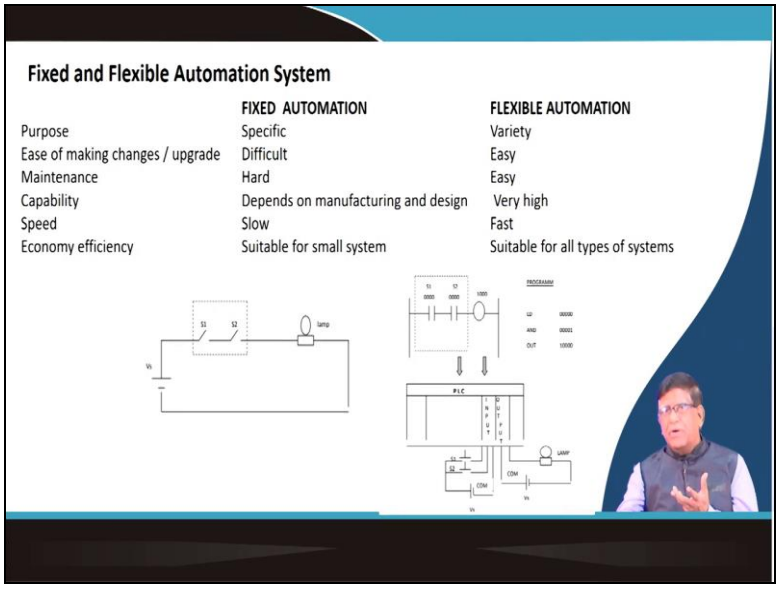
So, it can occur in batches including new addition of the sequence repetitions say for example your suppose you are doing the concrete mixing. In case of concrete mixing where that cement water stones or the chips sand you need to mix it over there then when they are coming over there at after the whole material is coming you will be giving rotating your that container at certain speed. Now depending on what is the in ingredient coming how much cement coming how much water coming how much should be the your stone ships if you want to mix it over there that can be programmed.

And then once that mix has come that will be having its own weight and density at that time to get the better mix at what RPM it should be there or whether you need to shake those things can be programmed and when these are done automatically that is a programmable automation. And then there is a flexibility that flexible is the for various program sequences and cannot be executed in batches.

It is just you can it is in batch bit system what is there it is coming dispatch I have done it has gone over there but in flexible it cannot be done in a bit it is coming over there it can be adjusted with the situations with any time. So, here in flexible one automated sequences can change without any lag we can do whatever way you want to and it is of course this will be expensive in initial this implementations.

You can see about this figure have taken from this references given over here you can try to make a bigger of this table for comparing and then trying to find out some examples from the bulk material handling where such type of things are there.

(Refer Slide Time: 16:28)



Now as we can see if you compare a fixed automation and flexible automation we can see them while studying what are their purposes that means your fixed automation will be for a specific purposes and then in a flexible automation it can be variety of purposes can be accommodated. And then if you consider the ease of making changes or upgrade that is your if you are having a fixed automation the things are all parameters are fixed.

So, to change it will be difficult but in a flexible automation it is easy you can you can adjust the you want a different quality of product if you want a different size of things you can have the automated system by which exactly you can handle it and in maintenance also because this is in a flexible system you are having the access to the things over there they have made in such a way that they can be easily maintained.

But in a fixed automations it is done forever it is expected to operate for that and so, that is why you will not like to get it very easily maintained then it has got the capability wise the fixed automation depending on that what you have ordered for what your the user at that time what they have contemplated that these are the things required accordingly the manufacturer has made and they will be giving that capability.

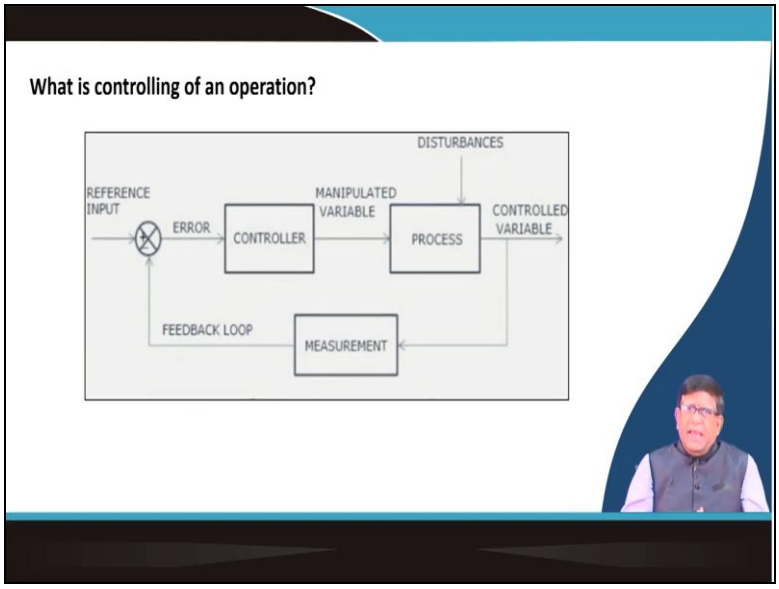
But in case of flexible because it has at the time of conceptualization they have widely considered that these many things may come. So, that is why the capability is very high and that speed normally the fixed automation with a low speed flexible automations will be going at a faster speed. And economy of efficiency it is said that it can be normally for small system you go for a fixed type of automation but for a large capacity of our more most of the

material handling systems you will find that if required our flexible automation is much better.

So, you can see a flicks automations is like this you have got a switch on and off that bulb you cannot control but if you have a flexible you are having a control system by which by there are different options that which options will be using depending on that you can get different output. That is exactly in this control you are having certain freedom you can select this or that and then accordingly you can put it.

Say if your it is going on just only you may have a bulb which will be giving only within one colour but you can have some options over here you fitted that ok I want the green blue or red or different type of colour depending on the things. So, that option is there. So, you can do it over there. So, that is way how in a flexible system you have different thing.

(Refer Slide Time: 19:25)



Now in any automation that means the most important thing is to know about the control. Whenever there will be a process in any control system whether it is your in a hoisting and winding the winding motor the case you are controlling or in a conveyor belt here that is depending on the load exactly at what speed you want to move it if you want to have this there will be certain control variables that which you will be controlling.

And then this control parameter is always controlled with respect to a certain reference input and there will be a controller and this controller whatever that your they will be manipulated variable is coming out of the controller that means based on that the process will be

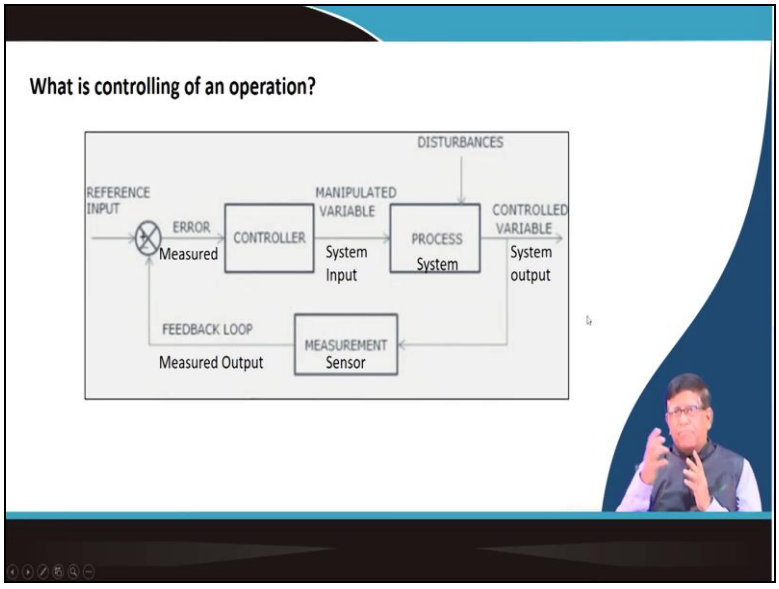
controlled the process operations will be adjusted according to this input command and then this will be exactly giving a result.

But at that time the environmental disturbances that in the surrounding on which it work it may change and accordingly this variable whatever is coming out you will be measuring you are keeping a watch on need by. And then you will be giving a feedback to this whatever is coming and they will be comparing it with finding out what is the error error is nothing but what is the deviation.

So, in a whole controlling system what it goes it is a closed loop. In that loop what is happening your one control variable that is you are say for example in a winder your what will be the speed that speed it is there. So, depending on that say for example you want to that is your change the speed when the human beings are transported or when the material is transported that could be different.

So, if you measure it that is exactly if you measure or if you give a command which one is coming accordingly they will be giving a signal from that that motor will be running at what speed they can do it over there. So, this is a basically a in a control system what you need to do is your how to find out that what are that your system output.

(Refer Slide Time: 21:56)



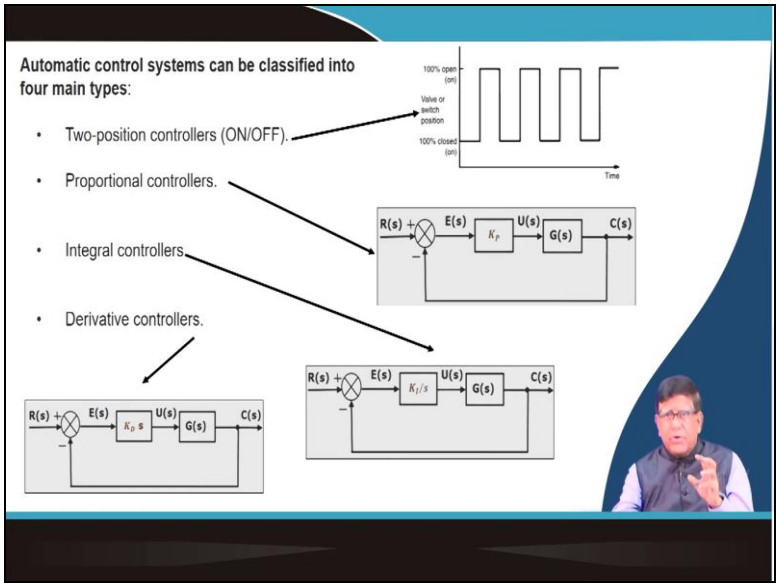
Your that output could be say if you are having in a in a processing plant you may be having that you want to know that after the crushing that is your what is the particular size what size is coming how much that is what is the average size if it is coming very big that means you

may have to give a more crushing energy will have to be applied to the crushers timing will have to be increased. So, like that.

So, you once the system output is sensed by the sensors and that measurement output will be coming as a feedback to your this and then they will be comparing and error will be measured out deviations will be determined. Once that signal that this is what is happening is given to the controller then what will happen a system input will be given and the system will be working in that system when some disturbances come the system output will vary.

So, if you are doing it over there automatically the system will be maintaining this control variable. So, I think you have understood the basic principle of controlling in an operation.

(Refer Slide Time: 23:09)



Now that controlling operations can be different type that is our the automatic control can be a two position controller or it can be a propos proportional control at this two position on off controller your signal will be coming just on and off that is your things maybe in many of the simple control system will be like that. But there are this feedback which we are telling how it reacts depending on that this three type of controllers are there that is your proportional controller integral controller and deviational derivative controller.

Now this what happens in a proportional controller that same signal that circuit which you have seen. Now if you are from the system the signal is coming and then your controller it has got a your output is your say u on time it is changing. Now suppose your this particular

one K p you can think it as a the ratio of your maybe this your u t by E s that or you can say that that U s that means which is the output it will be some factor multiplied into this.

Now this one if it is just proportional then you define that if this proportional constant of proportionality changes then accordingly you will be introduced a control that is whether that control required you will do it. Now sometimes this factor that is your controller factor it is not only taking as a proportion but it could be an integral that means this K i that is which is your now taking as an integral here if it is it is varying with time.

So, this output which will be coming will be an integrated effect of this. Say for example if you are controlling the you are measuring the noise in a noise you know that there is a that is your LEQ that we can equivalent noise which is nothing but say for example you are monitoring it for one hour in that one hour every second you are time finding out what is the noise signal coming and then you integrate it that over a period of one hour then you can find out ok this is the integrated noise coming after one hour.

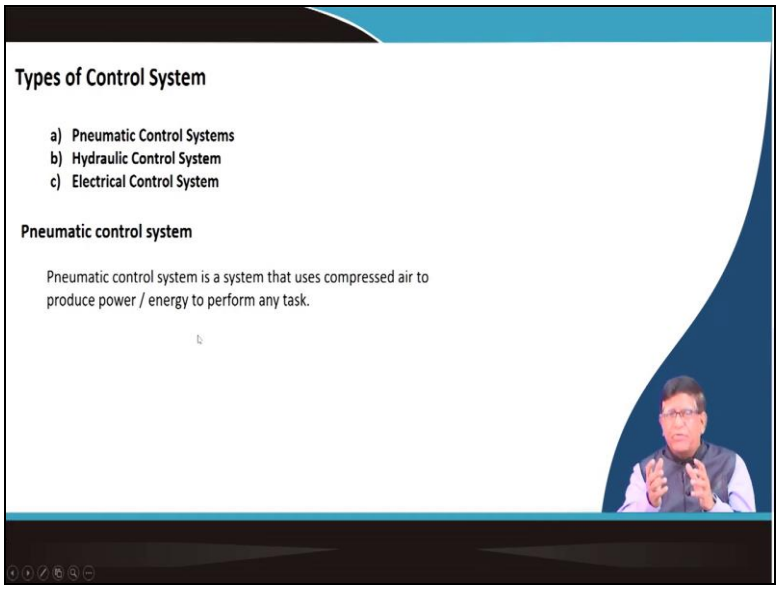
So, if you want to say that the operator he has got a limit of hearing that a particular noise level if it has increased that in one hour then he will have to be asked that ok you go then another person will be coming or something like that signal can be given. So, this is an integral controller where this controller is measuring the impacts integrating over a period of time that is an integrated controller.

But sometimes there is a derivative controller where it is nothing but that d du t that is u 2 is nothing but dE s by dt you can say that that input signal over a time you are integrating ok when you are taking a derivative that means you are taking the rate at what rate it is increasing or at what rate it is changing. Sometimes in some of the cases this rate is very very important you will find that exactly if in a in a slope of a overburdened material you have placed it over there.

Now they have got started surface movement you are finding. Now if that surface movement at what rate it is coming is more important are they getting highly accelerated that may hold that whole material may slide down. So, that rate is monitored and accordingly a signal will be given or it that people will be given the alarm that we need to do it over there so, that the operations there can be control.

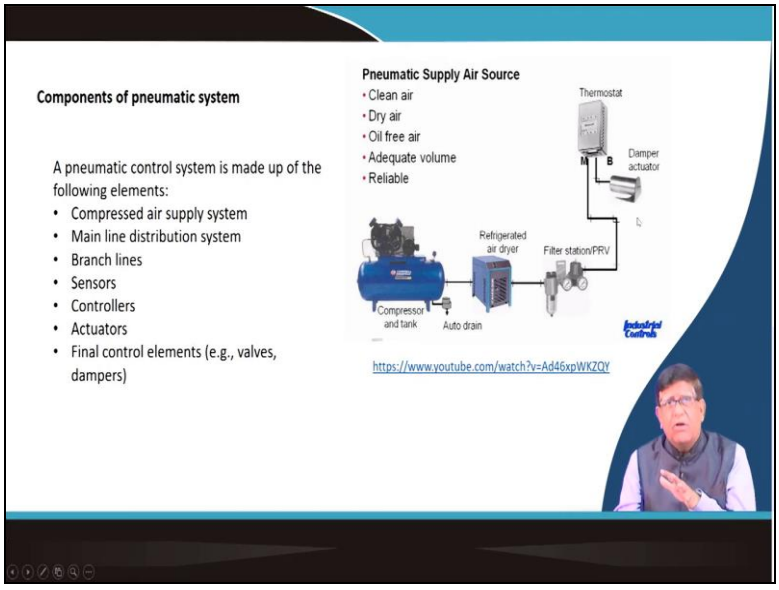
So, I think now you understand that what is automatic control in bulk material handling? How it will go?

(Refer Slide Time: 27:24)



So, this control when you will be actuating exactly the operating the machine there you can have a pneumatic control system, hydraulic control system or electric control system or electro hydraulic electropneumatic and the combination of it.

(Refer Slide Time: 27:47)



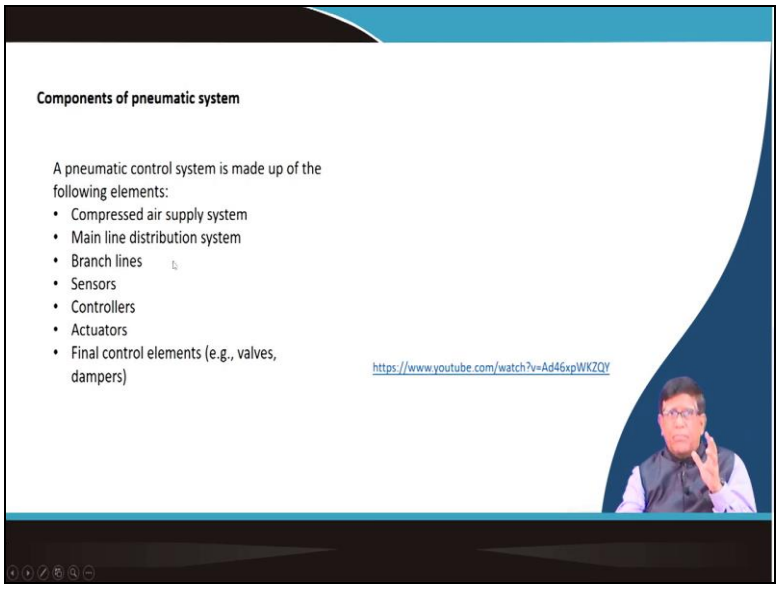
In a pneumatic control system basically you will be having a compressor from that compressor this your air will be that main component will be from the air you are compressing it over there then the it will be going to a pulse to the name this different distribution pattern then there will be it is going to the different branches where you want to

give it sensors then it will be having controller it will have actuator it will have the final control system.

For example that you want to do your braking system in a truck that is a pneumatically applied brake. So, you are controlling over there and how exactly those comes up your main thing is there will be a compressors and this will be taking that your clean air and then it will be sending it through your. Whether you want a cooling in some of the some of the systems in a material handling system you will have to get this things cool.

And then you can filter and with the number of valves the control measured way you will be supplying and then you may be controlling the thermostats and then there could be your actuators and all will be working and this is a typical circuit of a this done.

(Refer Slide Time: 28:49)



You can do a number of activities by yourself this is a student's project. You can see in the website how a conveyor belt can be sensed for different purposes this is something a belt that is used for a unit load as in the your airport and all you have seen some conveyor belt there how the control can be in this type of nowadays with the simple that your integrated circuit chips are available with that you can do some of the projects like this.

(Refer Slide Time: 29:19)

But now one thing is there that number of my bulk material handling systems have got different type of automated systems you need to see. But what exactly most important here I want to tell you that is your whole control system and whole of automations it will be whether you are going for a pneumatic control hydraulic control or of this your electric control you will have to know the control circuitry.

And for knowing the control circuit that the pneumatics and hydraulics is a very very important subject those who are having some interest in this subject you will have to know and for them as a as a learning exercise. Try to collect the symbols used in a pneumatic circuit or in a hydraulic circuit and try to read that whether you can learn how to understand the circuit.

So, that is you will have to do some self studies for understanding the symbols used in a pneumatic circuit and how a circuit should be read ok thank you very much.