Applied Ergonomics
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Module – 02
Lecture – 07

Hello and welcome to this lecture 7 of applied ergonomics. We were talking about the different flowcharts and we had also mentioned about some practical examples related to the outline the process outline chart the materials flow chart. And also the 200 system the 200 chart that we describe. The other kind of representation is a flow diagram which again can be found out in this particular slide here.

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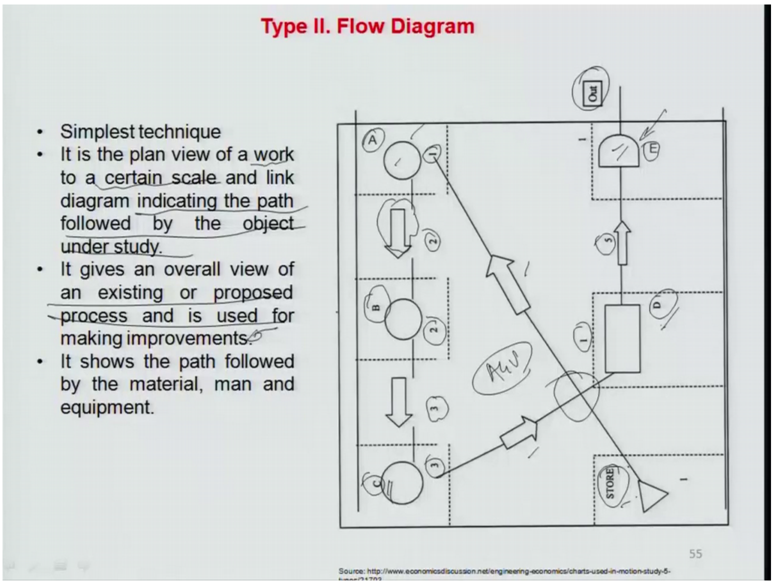

The purpose of a flow diagram is like in a simplest manager you could record anything as the way that material again is flowing from stores in terms of you know various things like transportation of the materials and probably operations and if some inspection is involved. So, in this case for example a material flows from a permanent storage all the way to let say station A which does certain operation A, you know certain operation one beyond which the material again flows from 1 to station 2. And so, there is a transportation of material between station 1 station A and station B.

So, the operation B is being performed in station 2. And similarly the material flows again between 2 and 3 where materials C and operation C is being done on the particular work piece. So, you are representing this in terms of transportation and operations and then again, it is operated where it goes to an inspection station one where at inspection activities D is carried out followed by let say transportation to again another area, which is where the output would go from. And so typically it has to wait up till the carriage comes and takes this material from this station to the next probably process.

So, there is an output and there is a temporary delay of the material waiting before it is picked up you know. So, that you can have another set of material flow back. So, this is a very simple view of the whole work plan to a certain scale, and you can link the diagram indicating the path followed by the object under study to give an idea of how much length scales are being translated between the storage. Or let say the operations are the different inspection steps which are there. So, it gives an overall view of an existing or proposed process and can be used for making improvements to the process supposing there is too much of crises cross you know this you are seeing already is a criss cross between the material going from section C to the inspection on the store to A.

So, can I develop some paths where there are not many delays because of the criss cross, let say if I had an agv system here automated guided vehicle; obviously, they will have to schedule that the criss cross may not happen at the same point of time. So, that there are 2 vehicles colliding into each other. So, that kind of a case should not happening. So, it is a very important layout requirement, that there should not be any hindrance to the flow you know and based on that you take certain decisions and also changed certain layouts.

So, it shows that sort of the path followed by material man an equipment is done in a very uniform manner. So, try to do as much as parallelity parallelism into planning such layouts that is the whole ideas. So, this is the flow diagram.

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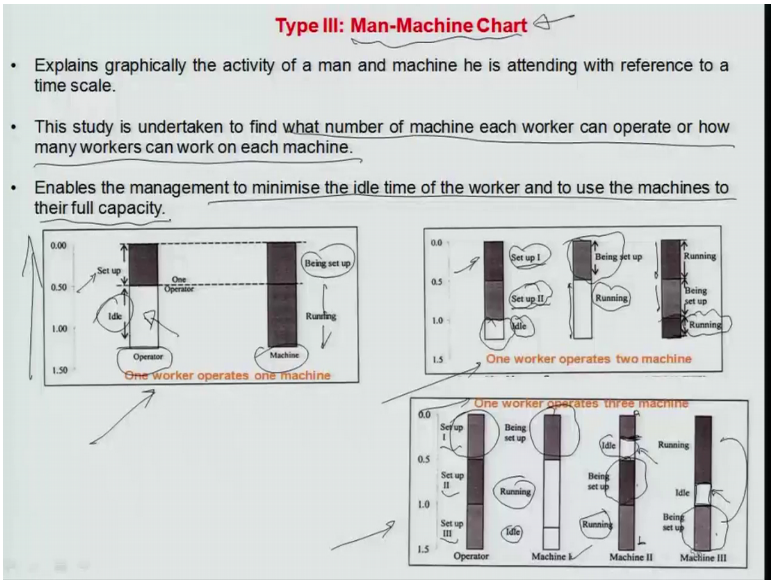

So, we also have various other representations for recording the data. For example, this is a man machine chart which talks about how you know an operator can be mapped in terms of his setup, and let say working an idle times with respect to machine for example, let say look at this one operator one machine system. So, this is the machine a time scale is associated on the y axis. And this is the operator. So, you can see that when the operator is setting up the machine the machine is being setup. So, the machine is idle at that time when it is being set up the moment the setup is completed the operator becomes idle as the machine starts running. So, this is an important problem which has to be solved that how to reduce some of these idle time.

So, best idea would be that if I give one worker 2 machines to operate on. Now you see here in this case you have 2 different setups for the machine one and machine 2 which has to be executed by the same worker. So, the machine one is being setup for the first time between 0 and 0.5 seconds by the worker. And the moment this is setup you know it the running can start of that particular machine after 0.5 seconds. And now the worker does not you know remain idle because he has to setup another time or another machine which can be setup 2.

And so that you know you can make the so as you are doing it machine one is already running and machine 2 is being setup. And now you can I you can see that the machine 2 starts running here, and there is a small amount of time overlapping between these 2 machines where the operator still idle. So, can I actually now load 3 machines you know on the same operate. So, this way I can keep on utilizing the operators time and engagement between multiple machines.

So, that we do not have any question of overlap time wise between 2 machines; that means, setup being done together that that is avoided and you can also give a time by time very nice sequence for the operator. So, that all the 3 4 different machines which engages in completely are you know, worked in parallel at different start points. So, in this case for example, 3 op 3 machine one operator system you see that setup one setup 2 and setup 3 indicates the setup time for 3 machines.

So, the operator now is between 0 and 0.5 seconds setting up the first machine between you know this, this can be seen here between 0.5 and 1 second setting up the second machine and between, let us say one and one point second setting up the third machine and so he is never idle and if you look at how the machine is being run. So, after that this starts running and there is some idle time then again when the second machine is setup this starts running it goes all the way from here to this point you know this point. And there is some idle time. And similarly when the third machine is being setup it will start the running and then it will have some idle time. So, this even idle time can be avoided by packing more machines in a manner.

So, that you have very less slack between the machine wait time. And the operator wait times these a very nice representation one particular board to illustrate, how much of idle times are there scales are there on the machines how much of idle times are there on the operators. So, it is a study which is undertaken to find what number of machines each worker and operate. And how many workers can work on each machines and it enables the management to sort of minimize the ideal time of worker and also that of machines and you can use the machines in full capacity by looking at the man machine chart. So, these are nothing, but organized intelligent representations done in carried out in a manner. So, that you have less you know idle times and less slack as far as possible in a work system.

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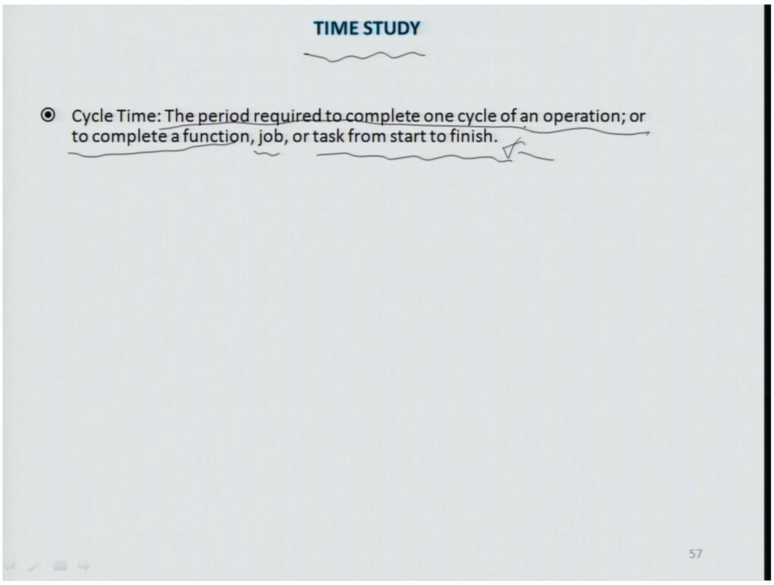

So, we will now start again detailing some of the time studies. So, I think I had mentioned about time study that whenever search works and tasks are identified and process sequences being develop you associate some time scales with respect to the independent work and independent task which are there in such work systems. And then you know the time scales can actually add up together to complete the hole operation and we can call this the addition of such time scales of the hole operation as one cycle time. So, the period required to complete one cycle of an operation.

A complete operation which has being split up, now into several tasks task could be materials flow delays task could be related to let say machining you saw some of the examples earlier. So, to complete the whole function of the job of the task from start to finish is what a cycle time really would be and so a cycle times are very critical issue particularly when you have multiple work centers working together in a certain sequence for the for the for the task to be carried out and one such illustration is assembly lines, where there are multiple work centers multiple staff working together.

And somehow the behavior of each staff with respect to the other matters overall in the whole productivity or the speed at which the overall assembly line can be operated. So, we will do some problem examples as well to sort of get a feel of what exactly, I am talking about time study and how we can do it. So, we will just first look into some techniques of how time studies can be carried out.

So, the first technique I think simo chart I had already introduced earlier.

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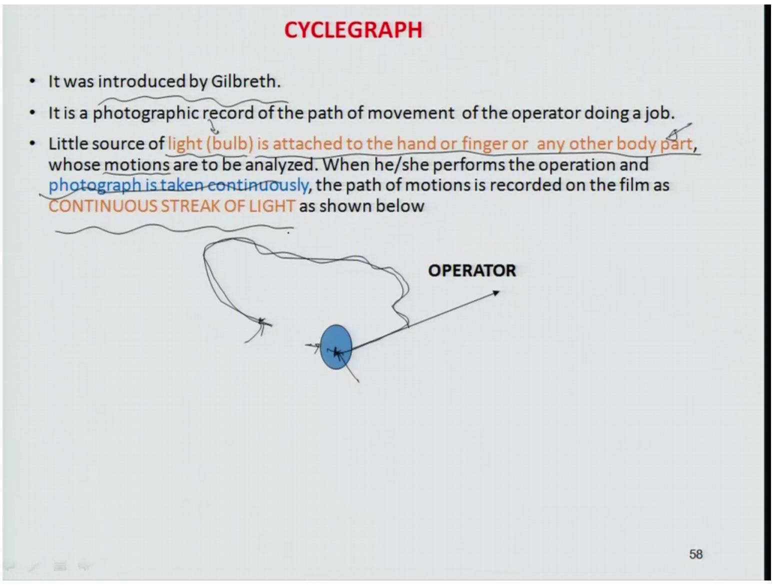

Where we talked about simultaneous motion and we talked about assigning time scales of simultaneous to such simultaneous motions. The other very important time study technique which was introduced by gilbreath was by looking at you know a little source of light bulb maybe a small led in the current days you know which is attached to the hand, or finger of any operator or maybe any other body part which is involved in the motion sequence associated with the task to be executed and this particular motion is being trapped and the in terms of continuously taken photograph. So, basically you see this is a small source of light and the light is actually going through this path as the operator execute the whole task and so you can actually get a very good idea about the times scales associated with such a task as the motion completes from one such snapshot to the other snapshot.

So, you can have a continues streak of light this way, when you film this at a certain speed. So, that you define more or less the work zone based on such speeds and because your recording at a certain rate; obviously, the time scales automatically come out. So, exact start point and exact end point can be precisely found out for a certain task in this particular manner and with this information of the framing rate as well as you know the begging of the streak. And the end of the streak one could suitably get very accurate values of time scales associated with different motion sequences a similar idea comes through this Chrono cycle graph, which is a especially type which is a special type of cycle graph here.

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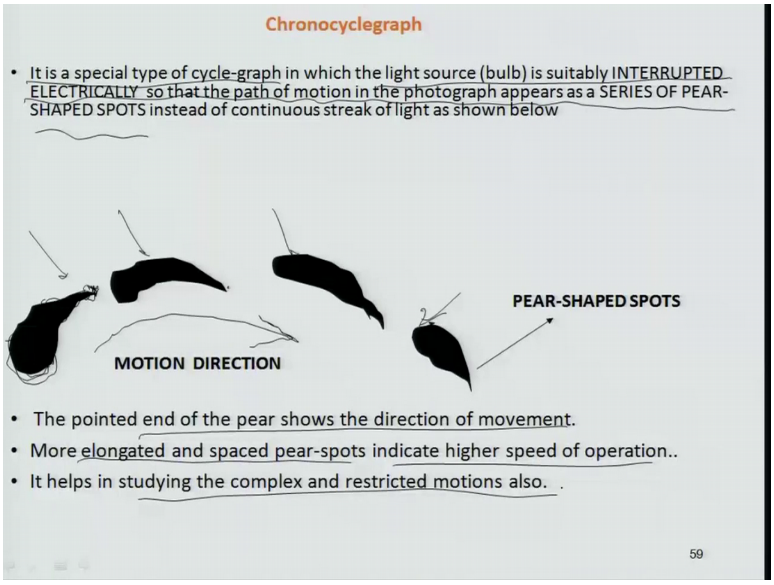

You know the light source is suitably interrupted electrically. So, that the path of motion in the photograph of appear as the series of pear shaped spots. Basically you know you can get an idea of directions in this particular think. So, you are when you are imaging or introducing an imaging modality you can change, the let say the acquisition screen size in a manner.

So, that you get a larger perspective or a larger area and one case and as the window changes the spot of light also become smaller and smaller. So, in this way you can play around with the imaging modalities. So, that you have a highest spot size at some time and then maybe you know keep on changing the way the variation or keep on changing with time the spot size. So, that you have a pear shape and so the whole motion direction could be sort of split up into such pear shapes or arrows.

So, these are some arrows for examples. So, these arrows are indicating the motion direction so the why pear shaped why we do this image control is just because we want to find out what is the direction so direction is typically from the broad end where the window of light was quit bigger or light acquisition to the smaller. And where the window of the light acquisition was smaller. So, we try to find out what is exactly the direction at a certain point of time associated with the certain task or a certain process.

So, the point at end of the pear shows the direction of movement. And more elongated and space pear spots indicate higher speeds of operation, and so it can help in studying complex and restricted motion also which otherwise may be little difficult that exactly let say it is in a corner the motion is along the corner. And it is very difficult to otherwise find out what is the start and stop of such a motion so you could actually do this use this image analysis technique for intelligently finding out where exactly the hand is proceeding at what point of time which can be considered as the task in totality.

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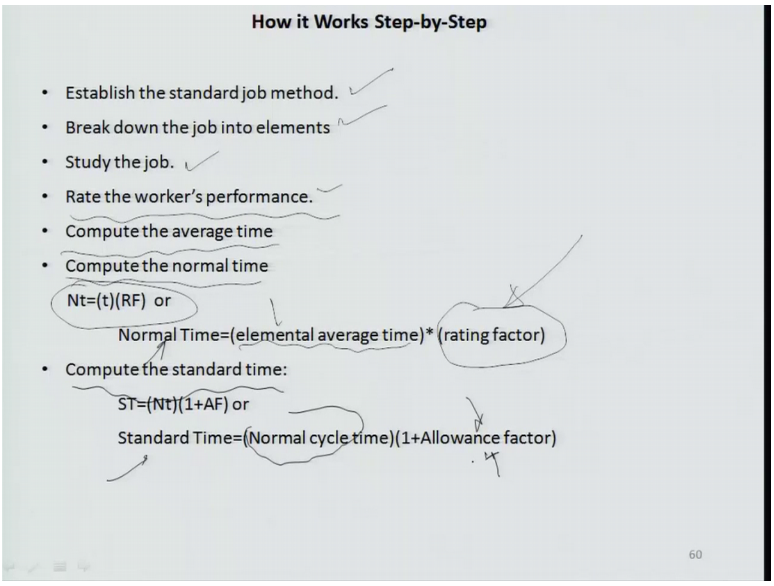

So, how time studies are carried out. So, typically you establish standard job method first you have been doing that using. So, many cycle charts. So, many different forms of representation outline charts etcetera. You know which you did in the first module of the last lecture then you break down the jobs into elements study the jobs properly rate the workers performance this is a very important aspect of time study, that the person may be very highly skilled to deliver at a faster rate or a person may be less skilled to deliver at a slower rate. So, you should have some kind of a rating based on if a performance of a person is high or low you could actually associate varied time scales and keep a slag in a system which kind of accommodates that aspect from variation from person to person.

So, that you are times could be more generic more generically applied more accurate. So, on so forth and then you compute average time scales, and compute the normal time which is actually norm you know. It is the you can say the elemental time element is one element of a certain task times the rating factor. So, here is where you are trying to give some heat to the workers performance. So, if I rate at a particular worker at 1.1; that means, he is doing 110 percent you know the actual rating that an average worker would do.

So, this rating factor actually becomes important in terms of the individual performances and then you have a standard time which is actually related to what this normal time is and int introducing the normal time. And then an allowance factor and these allowance factor is typically made because there is always a certain degree of slag that the management wishes for smooth flow associated with the system it is not that you can keep at 0 slag. There is some allowance in between which is kept in terms of times because there may be issues related to different noncompliance factors which may couple and such a work system.

For example, the material which comes may be damaged on a particular case where there may be sudden change you know the material that you have picked up for assembly, you realize it is not would you throw it and take another one another sample. There some slag which is always need needed for a smooth flow of any system. And so therefore, standard time is set in accordance with that normal cycle time and with an allowance factor which provide. So, let us say do a small example.

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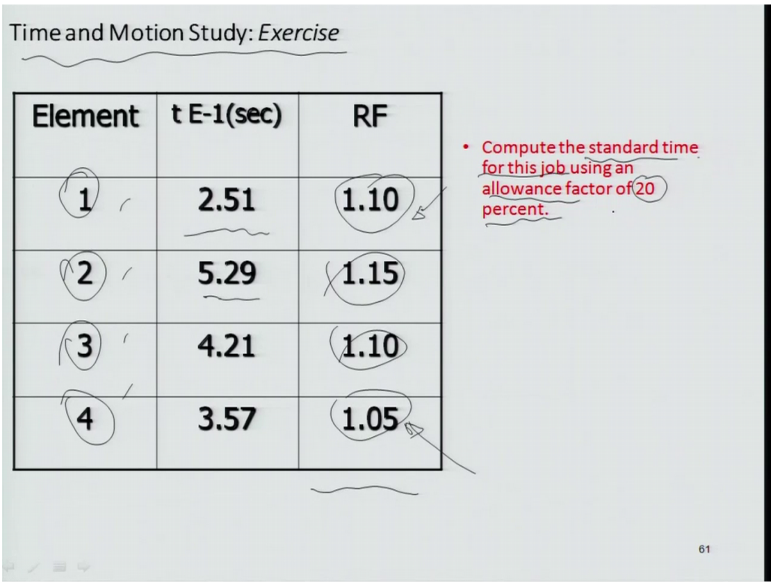

So, we have particular time study to be done of a job, where we have split up into different elements. So, the whole job is divided into 4 different task of 4 different elements and each of these elements have different time scales associated with it. For example, task one takes about 0.251 seconds 2 takes about 0.5 2 9 seconds. There is a rating factors associated with each of these because there are been done by 4 different operators who one of them operates 110 percent efficiency and other is little bit lower at 105 percent efficiency so on so forth and then, you have again the requirement is to calculate what is the overall standard time of this particular job and you have to use an allowance factor of 20 percent.

So, do whatever time scales you generate normal times of the whole process including all these 4 elements couple together you have to multiply or you had to do it at 120 percent to calculate what is going to be the actual time scales, let us do it.

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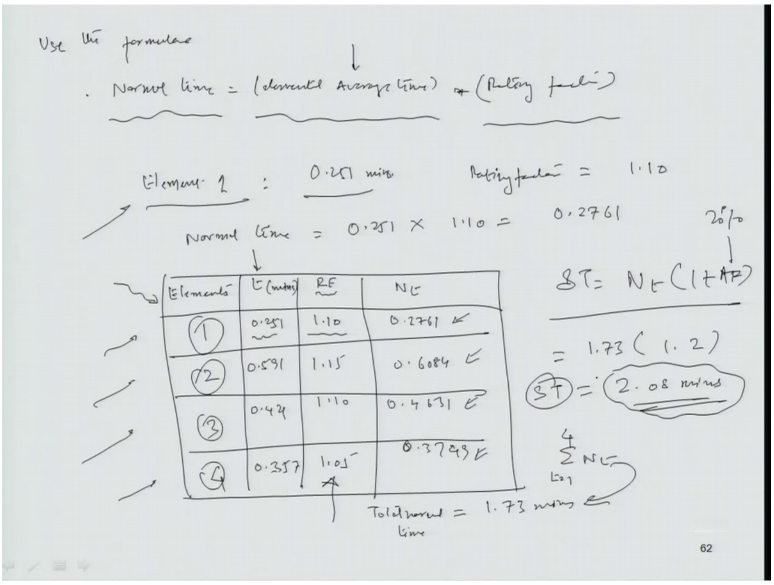

So, we use just the simple formulation here normal time equals the elemental average time times the rating factor. Now how we have arrived at the elemental average time is based on some of the techniques that I have earlier illustrated may be do video filming or micro filming. And at some time scales or just like to mention that in the simo chart example we had also talked about time unit. So, there the time unit about 1 2000 of a minute. So, it is a very small time unit.

So, therefore, essentially we are filming all the micro motions which are associated with such time scales or time units. And I would like to sort of say here that when you do time studies or when you do let say you know motion study etcetera. There is always how small or what is the resolution at which you can do this at what is the minimum level in which you can record. So, that you know you get the more precision or more accuracy and the whole process.

So, you have normal time which is associated with the elemental average time and rating factor. So, I do this for all the elements for example, if I looked at element 1. For example, you have a total elemental average time given as 0 0.251 time units let say minutes you know and I have a rating factor for this particular operator who is delivering the element one has about 100 and you know he does it at 110 percent. So, the rating factor is 1.10. So, I will have the normal time estimated in this particular case as the elemental time average time times rating factor this becomes equal to 0.2761. Similarly, you could do it for multiple elements I am go to make table here which talks about different elements. So, you have elements here listed as 1 2 3 4.

So, there are different 4 different elements listed here and there are different time scales and rating factors we are associated the elemental average times are written down as 0 0.251. Let us say these are minutes then you have 0 0.5 9 1 0.4 2 1 and similarly 0.3 5 7 these are found out or these are being reported in this particular table which has measured the average time scales you know associated with this 4 task the rating factors assign. So, the r f is assign to be 110 percent for the operator working on the first task element, and let us say 1.1 5 here 1.1 0 here and 1.0 5 here.

So, now there can be 2 issues one is that we can look into each element of a certain task being done by a single operator and say how efficiently is delivering element 1, how efficiently is delivering element 2 etcetera the other issue could be related to 2 different task which are plan together for you know greater cause or a great let us say a task assembly or a job. So, it all depends on how you infer on a particular situation so supposing, if I had a case where on a machine shop.

For example, let us say a C n C or n C system there is an operator who actually inspects a cylinder block using pressure gauge and then he also loads this in n C machine centre one. And from centre one it goes to centre 2 to centre there so on so forth. So, in that even the efficiency of checking the particular engine block using a pressure gauge of different, let us say times during the whole shift of operation may be different by the worker. For example, if this is a very heavy task where there is.

Let us say such a gauge which is balanced through a spring balance overhead and you are pulling this gauge and putting it into a certain block and doing it for 3 blocks or certain cylinder doing it for 3 or 4 cylinder is in a single block, it is a very heavy task. So, probably loading the block into the machine may not be that heavy in comparison to this inspection that you are carrying out. And so therefore, your efficiency may die down towards the end of the shift where you have already been you know exercising this for multiple times. For example, some machine shop or some such C n C line makes about 3 hundred blocks in a particular shift of 8 hours. So, on operator towards the beginning may have cyclic greater efficiency on the heavier tasks and towards the end may have lowering down of the efficiency more for the heavier task. In comparison to the lighter task. So, you could work out the details in such a context on the other hand it could also be a case where you are having let us say multiple task given a certain process sequence, which is about let us say the car making process between weld and paint and assembly. So, there you are doing a task study. So, you basically concern more with one individual operator one individual station as one task.

So, it is upon you how you basically trying to introduce the concept of the work study. So, whatever it is. So, this r f can vary between a single operator as you saw in case one, the example one or between multiple operators where multiple stakeholders are involved for a process different task are done by multiple operators for a process from a case to case basis. So, here the total normal times which are involved here. For example, are just a product between the elemental average time and the rating factor. So, you give this as 0.276 1.608 4.4631 and 0.3749. So, a total amount of time which is spent here at the total normal time which is spent here is about close to 1.73 minutes it is a summation of all antes t varying between 1 to 4. And here we can calculate that because there is a 20 percent allowance factor.

So, the standard time for this particular operation will come out to be the normal times normal time times of one plus the allowance factor. So, in this case normal time is 1.73 minutes you have just multiply that by 1.2 allowance factor is 20 percent. So, 0.2 and so the standard time you can say for this particular operation is about 2.08 minutes. So, that is how you record the standard times for different operations. So, an element an operation which is comprised of 4 different task elements which are having individual components of their normal times based on the operator efficiency, the average operator efficiency is mapped in terms of the standard time which I will assign finally, to this particular set of 4 elements constituting one particular job.

So, that is how we do the time study. So, I think I will close on here this particular module. And the next module we will see how different time scales associated with different operators may sometimes balance or disbalance an assembly line. And may play it is role in terms of increase decrease productivity. So, as if now.

Thank you very much.