**Work System Design**
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# Lecture – 48
# Work Sampling: Examples

Hello friends, welcome to session 48 of the course on work system design and currently, we are in the 10th week of our discussion and the third session for week 10, we are trying to see the various examples through which we can calculate the number of observations as well as we will see how to calculate a standard time based on the concept of work sampling. So, in the previous week if you remembered in week number 9 our target was to find out tools and techniques.

That can help us to establish a standard time for performing the task prior to that 4 weeks we focused on method study in which we were trying to establish the one best method or a better method of doing the work. Now we are trying to find out how we can set the standard time for performing the work using the method which we have already developed and in our work measurement study.

We have already seen that broadly there are 4 techniques which can be used for setting up of the standard time. The first one is a stopwatch type of time study in which we have already seen that the continuous observation of the worker who is performing the work based on the standard method is done the time is noted down averaged out * the performance rating factor to get or calculate the basic or the normal time.

To which the allowances are added to get the standard time so that is a simple time study approach using the stopwatch then we shifted our attention on work sampling during this week and if you remember in the very first session we tried to differentiate between the work sampling and the stopwatch type of time study and they were number of differences which were laid out and we were able to understand that how work sampling is different.

From stop watch type of time study so stopwatch time study is also relevant and is most commonly used and it gives us a lot of data which can help us to set the standard time.

Sometimes it will give us some information also regarding fine tuning the current method of doing the work also. We may identify some of the work elements which are taking excessively long time and we may try to work on them.

We may try to eliminate; we may try to modify them so that our overall working procedure is also improved. So, the stopwatch time study has got its own merits as well as advantages but the work sampling has got its own merits and advantages and in the previous 2 sessions we have seen in the very first session that is session number 46. We tried to understand the basic concept of work sampling.

Why we need to do work sampling? how it is different from stop watch type of time study then we shifted of our attention towards the procedure once we know that yes this approach exists it can help us to establish the standard time for performing that task then we switched our attention to the procedure, the process that has to be followed in work sampling and there we have seen that first we have to set up the work sampling procedure.

We need to do some ground work then we have to actually perform the work sampling plan where a time study analyst will actually go physically to the shop floor and try to see whether the worker is working or he or she is idle and then finally whatever data is produced as an outcome of the work sampling is analyzed it is statistically put into equations and we are able to find out maybe the number of observations required to perform the work sampling or to find out the standard time required for a performing the task so that we have already seen few equations.

We have seen in the previous slide I can understand that sometimes looking at the equations it becomes difficult to understand that how the actual calculations are done. So, once we look at the actual data the actual problem that this is a problem on the shop floor and then we try to use this data put this data into the standard formula. And try to calculate something that things become more and more clear.

So, today we will try to see certain examples which will help us to make our understanding even more clear. So, let us see one by one so before going to the examples let us just revise what we have already covered.

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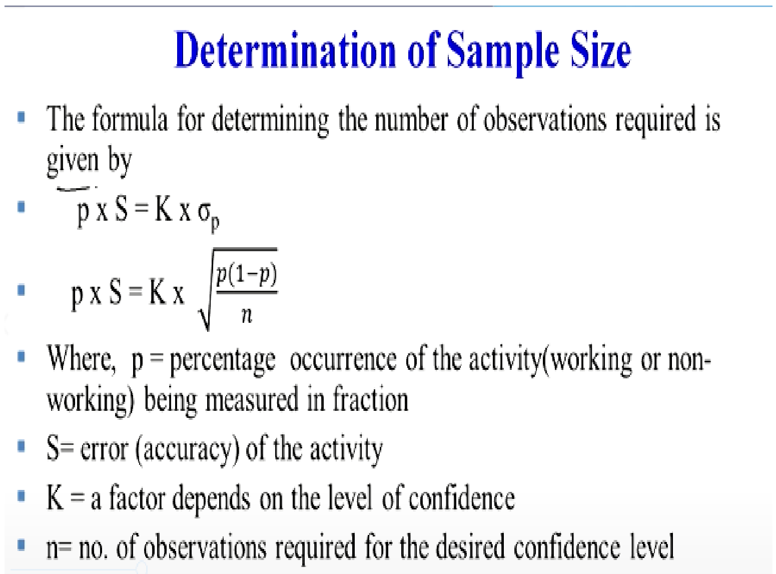


So, we can just refer back this equation which is going to give us the number of observations so this is sigma p already we have seen this is the representation of sigma p which we have already seen in the previous session. P is already known to you that it is a fraction of working or non working activity and is the number of observations which is already known to all of you number of observations already known.

So, this we have to sometimes we have to calculate then K is a parameter which depends on the level of confidence which we have already written here. So, we can have 99.9% or 95% that we have to decide based on the level of confidence. We will choose the factor K we have seen it can take a value of 1.96 in some cases then n is the number of observations required to achieve for the desired confidence level.

And S is the error accuracy of the activity so it can be +-5% or +-10% that we desired, error accuracy error or accuracy of the activity. So, this is the basic background this equation will help us to calculate the number of observations required to achieve for the desired confidence level. Now once we know the number of observations our main target is the standard time calculation per piece which we have to calculate with the allowances and the normal time.

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## Performance Standards

- **Normal Time per piece**
- Let R be the performance Rating index
- $T_h$ = hand controlled portion of effective time
- $T_m$= machine controlled effective time
- **Normal time** = $(T_h \times R) + T_m$
- Rating is applied to only manual(hand) controlled elements
- **Standard time** per piece is calculated by adding relevant **allowances** to the **normal time**.

So, these 2 terms are already known to you we have already calculated the standard time from the normal time*1+ the allowances. So, already we have a number of maybe 2 or 3 equations which help us to calculate the standard time from the normal time. But how to get the normal time so we have seen in the previous class performance standards we have seen some terms if we revise what we have covered we have seen the over all time.

We have seen the effective time; we have seen the effective time for the machine elements effective time for manually elements. So, this we have seen in the previous session so here again we can see once we are able to calculate the normal time this is calculated in case in the previous case based on the observed time and when it is * the rating factor. So, here although we will see how the observed time change.

In case of work sampling rating factor remains same. Let R be the performance rating index so this R will be known to us in the problem statement only. Th is the hand controlled portion of effective time Tm is the machine controlled effective time which I have already we have seen in the previous class. So, the normal time is the hand controlled effective time that is Th hand controlled factor* rating factor+Tm may be very very important.

You may remember that for a machine controlled effective time we do not multiply with the rating actor. So, Tm is not * with by the rating factor why because in machine control the work is done by a machine so we do not have any rating that whether it is slow or fast whatever is the capacity whatever is the speed of the machine it will perform the task as per that only.

So, that rating factor is being * with the hand controlled effective time and machine control effective time is added. So, this is a normal time and as per our standard practice we will add the losses as equation I have already written to this normal time to calculate the standard time. So, the only difference that is coming is allowances as we account for in our previous calculations.

As we have seen when we do a stopwatch type of time study we have the observed time we multiply it with the rating factor. So, we get the basic or the normal time and then we try to incorporate the allowances and get the standard time. So, the only allowances remain same the rating factor remains same only thing is how to get the observed time in this case. In this case we are calling it as the hand controlled portion of the effective time.

So, that how to calculate the hand controlled portion of the effective time and the machine controlled portion of the effective time. Or in nut shell how to calculate the effective time how to get the total time that is T0 over all time. So, this is the difference between work sampling and the stop watch type of time study. So, let us know go back go and see some examples now example 1.

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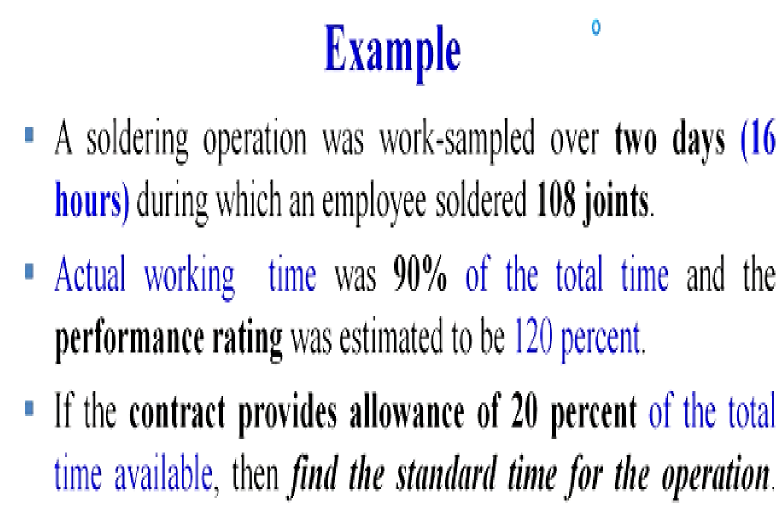

So, here you can see a soldering operation was work sample the work sampling problem over 2 days that is 16 hours 8 hours 2 days*8 hours shift. So, from there we get 16 hours during which an employee soldered 108 joints. So, this is what we call as production quantity which is already given this will help us to calculate the time per piece actual working time was 90% that is actual productive time of the total time 90% of the total time.

Total time is already 2*8 hours that is 16 hours and the performance rating is given as 120. So, performance rating is also given so what do we do we know we know R here already even in the problem we know as per my understanding the overall time that is2*8=16 hours already we know and what else is given 90% is given. I think we can calculate T effective from there that is 90% of the total time already known.

So, 90% of T0, we can calculate now in the contract if the contract provides allowance of 20% so the allowance is also known to us it is 20%. So, once we get the normal time we already know the allowances we can calculate the standard time easily. This is the problem at hand now you can do yourself try to solve this problem it is an easy problem. So, there is nothing much to be calculated.

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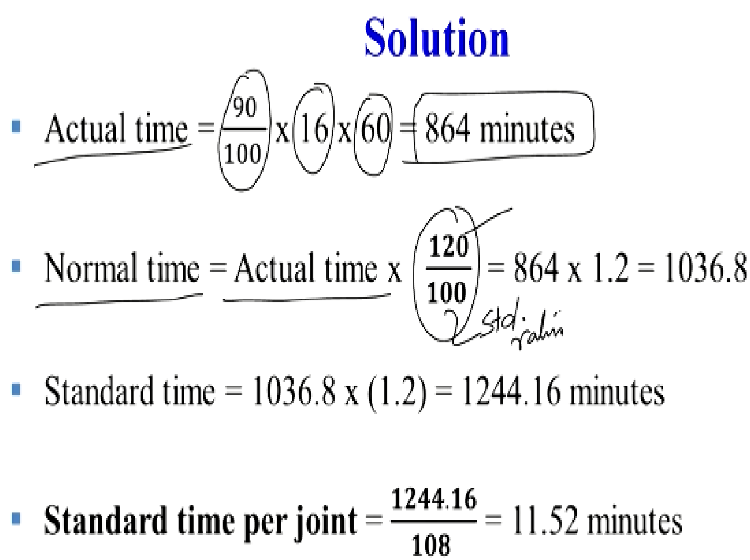


So, the actual time is 90% of the overall time converted into minutes so it is 864 minutes. This is actual time so normal time now is the actual time * the rating this is rating given this is the standard rating. So, this is 864*1.2=1036.8 the unit here are minutes then the standard time normal time which is already calculated from this actual time * rating factor. Actual time is calculated 90% of the total time total time is 8 hours*2 days that is 16 already known to you.

So, standard time is that this 1.2 comes from if you are using the formula normal time * 1 + allowances. So, 1 + allowances 1+allowances 20% 0.2 * the normal time. So, normal time already calculated 1036.8*1.2=1244.16 minutes. Now the standard time per joint how many joints are made production of quantity that I have already told is 108 it is already given in the problem.

We can refer back to the problem during which an employee soldered 108 joints. So, the production quantity is already known to us so the total standard time calculated after using the normal time + allowances we have already calculated and when we divide the production quantity we can very easily calculate the standard time per joint or per unit or per piece. So, this way work sampling approach can help us to find out the standard time.

So, where the difference is coming the difference is coming here where we are saying the actual time is 90% of the total time.

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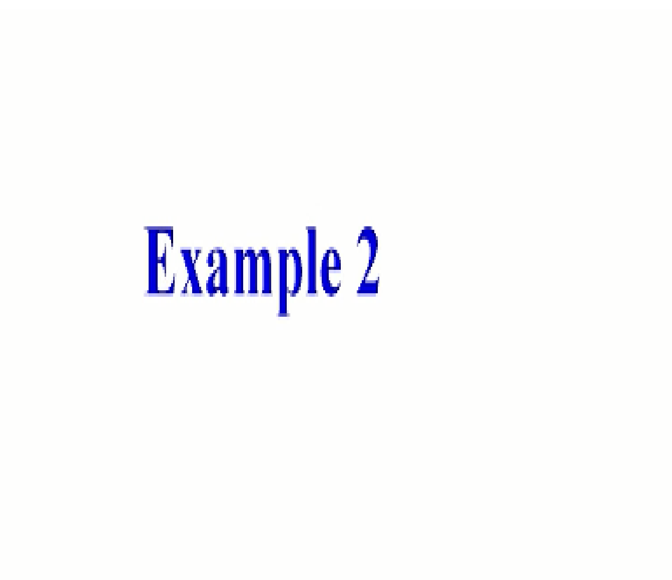


Let us now take the second problem that is example number 2 let us see what is the problem statement given here.

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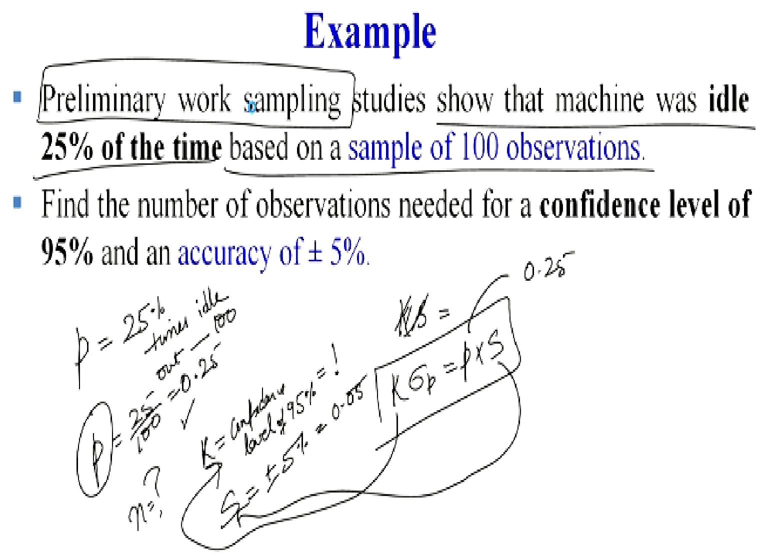


Preliminary work sampling this is important I think I have tried to refer to this earlier also, sometimes this value of p that is the percentage working or non-working activity that we have to assume or we have to do some preliminary investigation. So, preliminary work sampling studies show that the machine was idle 25% of the time based on a sample of hundred observations. So, 25% means that we can very easily from here.

Let us see now p is coming out to 25% times it is idle out of how much a sample of 100 observations. So, p comes out to be 25/100 0.25 so one of value is known to us find the number of observations needed so we need to find out n which is the number of observations needed for a confidence level of 95 percent. So, the value of K we have to see that what we have to take for a confidence level of 95%.

This is what one we have to locate that and then the accuracy the value of S is given as +-5% so this will become 0.05. So, this is we can say going to be the probable solution. Now we know that K*S= sorry K not, this we already know that sigma p *K= the p*S. I think this is the correct expression. So, K we have to see the confidence level of 95% sigma p already we know the equation p is already 0.25 and s is based on the accuracy that is +-5%.

So, let us see you know how the solution turns out to be.

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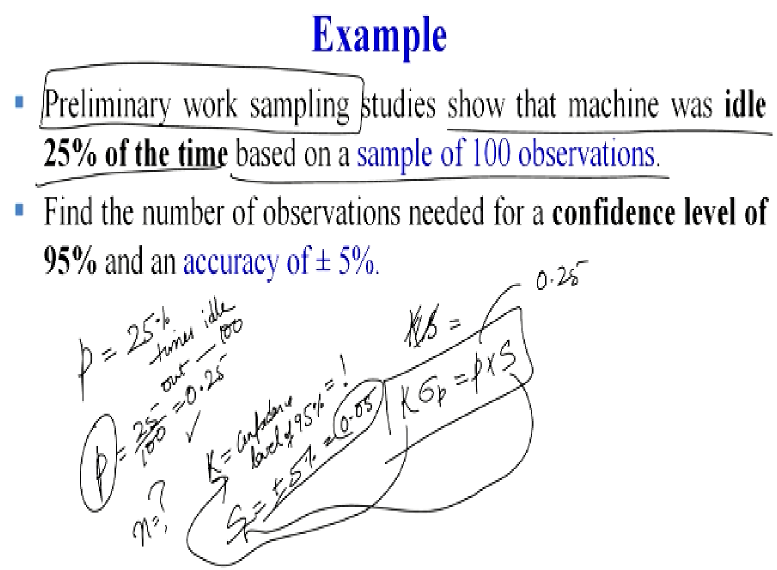


So, p*S=K*sigma p let me check if I am correct, so p*S=K*sigma p yes it is correct now p already value is given p=0.25 times idle so it is 25% of 100 observations this data is already given so from there we get 0.25 S is accuracy already given in the problem +-5% and if you remember I have also written 0.05 so S=+-5%=0.05 K is 1.96 for 95% confidence level 95% confidence level was given in the problem statement and according to that the K is 0.

Sorry 1.96 so our p this is p *S K*sigma p this is sigma p so again we are using p and n and from here we can calculate the value of n and n comes out to 4609 or 4610 approximately. So, the number of observations number of observations comes out to be 4610 for achieving or for a desired confidence level of 95% for achieving an accuracy of +-5%. So, this is way we can calculate the number of observations.

And if you can remember this is the previous data which we must have the 25% of the time machine remains idle once again I can read 25% time the machine was idle. So, this previous investigative date our previous data is required to solve these types of problems. Now let us see example number 3.

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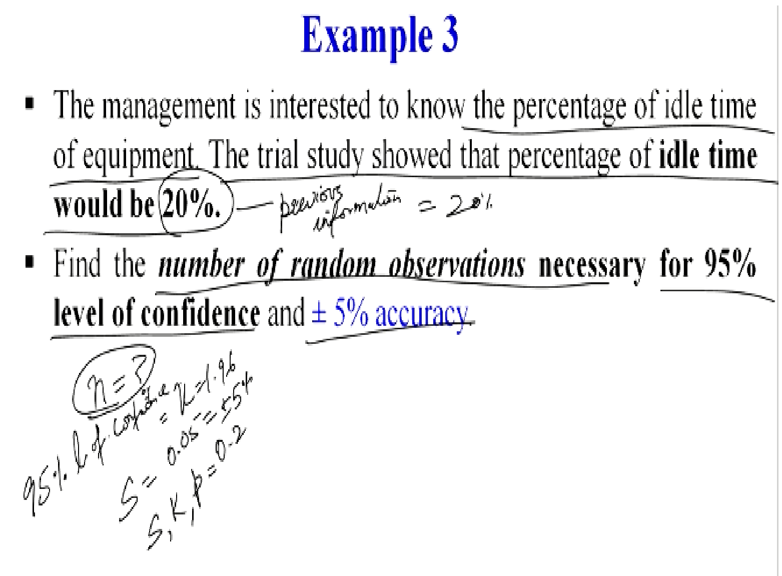


The management is interested to know the percentage of idle time of equipment. The percentage of idle time of equipment. The trial study showed that percentage of idle time would be 20% this is as I have told previous information and this is 20%. Now we have to find out the number of random observations so a number of random observations means n is the variable that we have to find out for 95% level of confidence.

So, for 95% level of confidence our K becomes 1.96 and S is again in this problem 0.05 because it is given as +- 5% accuracy. So, now S is known to us, K is known to us and p somehow is known to us the trial study showed the percentage of idle time would one be 20%. SO, in the beginning we know p=0.2 now what is required to be calculated here is the value of n which we have to find out. Now let us see that whatever information is given is it sufficient to find out the value of n.

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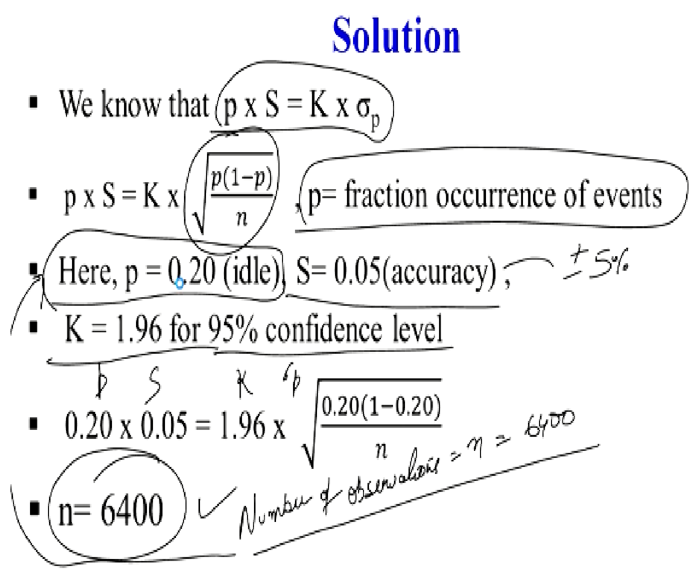


So, we know p*S=K*sigma p standard equation p*S=K* this is the expression already number of times we have seen for sigma p , p is the fraction occurrence of events which is already given so p is 0.20 idle which is given in the problem statement S is given because this is a +-5%K is 1.96 for 95% confidence level. So, if we use the same equation this is the value of p idle time and accuracy K and sigma p and if we put all the values n=64.

So, the number of observations that required again in this problem number of observations=n which is calculated is 6400. So, the number of observations are 6400. So, again for the calculating this ewe required one important information which is again I will take you to this point that is 20% of the time the machine is idle. So, that is important the initial the trail study showed that percentage of idle time would be 20%.

So, based on the previous historical data we have been able to find out the number of observations required. Let us see the last example of today that is example number 4.

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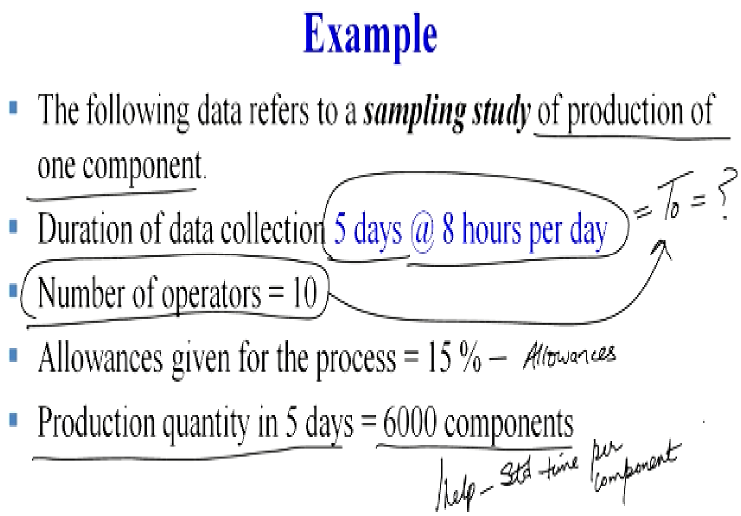


The following data refers to a sampling study of a production of one component. So, a component is being produced. Duration of data collection 5 days at the rate of 8 hours per day this is important because from here we will try to calculate our overall time. Number of operator is also given that is 10 this will also give us input for the calculation of the overall time. Allowances are also given and production quantity for 5 days.

The overall production quantity called even that is 6,000 components and this is will help us help when we calculate the standard time per component. So, let us see now how we can see this data so what will be our approach when we have to solve this.SO, first there is another problem maybe addition to this problem statement.

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## Example

- 5. Sampling data collected

| Days | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| No. of observations | 230 | 240 | 200 | 180 | 225 |
| Occurrence of activity | 200 | 190 | 170 | 150 | 210 |

- **Calculate standard time** of production of the component if average performance rating of a operator is 120 and the entire operation is **manual**.

So, this is sampling data collected so number of observations 1 2 3 4 and 5 occurrence and activity number of observations when the activity was occurring or the work was being done. Now what is a problem statement we have to calculate the standard time of production of the component if average performance rating of operator is 120. So, the rating is also given as 120 and the entire operation is manual.

So, if you remember in the previous session when we were studying the performance standards in that we have seen that we can have a machine effective time and we can have a manual effective time. So, here the whole operation has been given as manual so now if you see this is a well-established problem and we can calculate the standard time per piece. How it can be calculated if we see that most of the things are known to us.

Now if you remember as well the stopwatch times study first we will calculate the normal time or the basic time as the observed time multiply by the rating factor and then we calculate the standard time from the normal time+ the allowances. So, here the allowances are already given if you see allowances are given in the previous slide if I go back to the previous slide you can see allowances given for the process of 50%.

So, the allowances are known to us rating factor is also known to us as 120 we now need to find the normal time as well as this total time that has to be found out. Now let us see there are a number of observations occurrences of activity so we can add this do the summation of all these and do the summation of all these so this will give us the total number of observations and percentage occurrence of activity.

So, as far as my understanding goes if we go to the previous slide we have a lot of information so for calculating our T0 that is the overall time we can have 5 days 8 hours per day 10 number of operator's number of total time this is * if we want to bring it to minutes * 60. So, we can get T0 and from where we will get our T effective for getting a T effective this total T0 needs to be * the number of observations of working or productive divided by the total number of observations.

So, these observations already 5 data points are given so we get our T effective. So, accordingly we will move forward and see how the solution unfolds.

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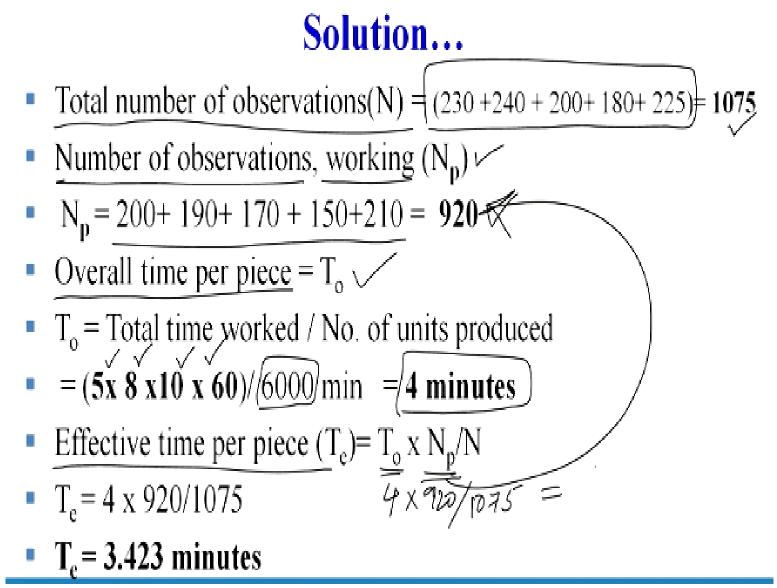


So, let us see the total number of observations already and I have told that we can do the summation of the values given in the table. Then the number of observations that is working so that is Np. We calculate all the observations working from the table again I can get back and try to explain from where we get n and so this observation summation will give us n number of observations.

And occurrence of activity summation of this row will give us what it will give us the actual working of observation or working observations so these are the working or productive number of observations working 920 total number of observations 1075. Now we have to calculate the overall time T0 now overall time per piece=T0 we again calculate. So, we can calculate this is T0 the total time total time work is 5 days 8 hours 10 operators 60 minutes.

So, this is the total time if we want to calculate per unit total time worked total number of number of units proved this is the overall time per piece T0. SO, number of pieces produced is 6000 which is already given in the problem. So, our overall time comes out to be 4 minutes but we have to now look at the effective time. So, the effective time per piece will be T that is T0 which is coming out to be 4*Np.

Np already we know working observations 920/n is the total number of observations 1075 and from here we can calculate 4*920/1075 T effective is coming out to be 3.423 minutes. So, now one time we have calculated that is the T effective time per piece already calculated 3.423. Now what do we do there are 2 other things which have to be incorporated first thing that we need to incorporate is the rating factor and the second thing we need to incorporate is the allowances.

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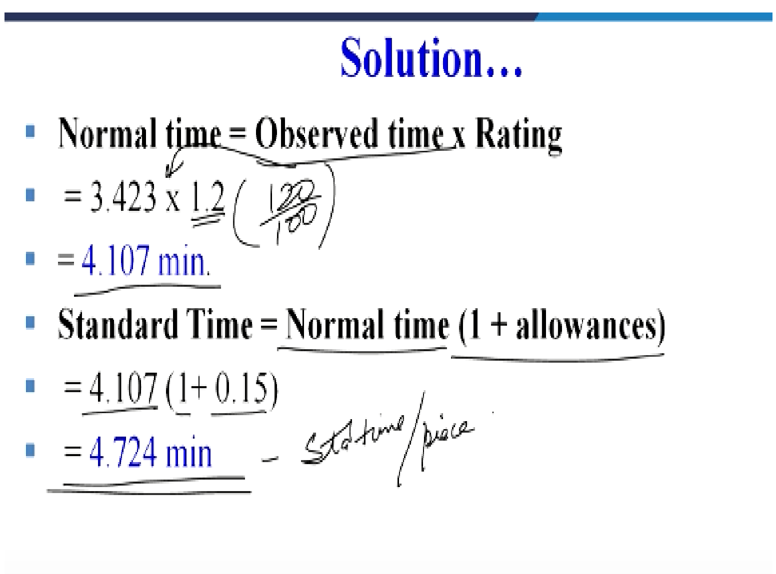


So, let us see now normal time is the observed time which we have already calculated 3.423* the rating factor that is basically 120/standard rating so we get 4.107 minutes and the standard time is normal time * 1 + allowances all of you know so this is the normal time 1+ allowances 50%

are given so 4.724 this is the standard time per piece, So, this way we can calculate the standard time.

Based on the number of observations taken by the time study analyst who goes to the shop floor at random intervals of time and records whether the worker is working or he is idle. So, this is another approach for finding out the standard time using the concept of statistics. So, with this we close the todays session in our next session we will try to understand other techniques which can help us to set the standard time for performing the task.

The task which is being performed by able bodied or skilled worker experienced worker using the approach the method the technique which has been developed as an outcome of the method study during our overall objective of the work system design. Thank you.