Orientation of Fibers
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Relations Among Yarn Count T, Twist Z, Packing Density, And Diameter D

This lecture, we want continue about our earlier theme about the Yarn unevenness. In the end oflast lecture, we said something about theHuberty's index of irregularity and we came to the conclusion that, something is wrong in the Martindale's concept of Sliver or Yarn irregularity.

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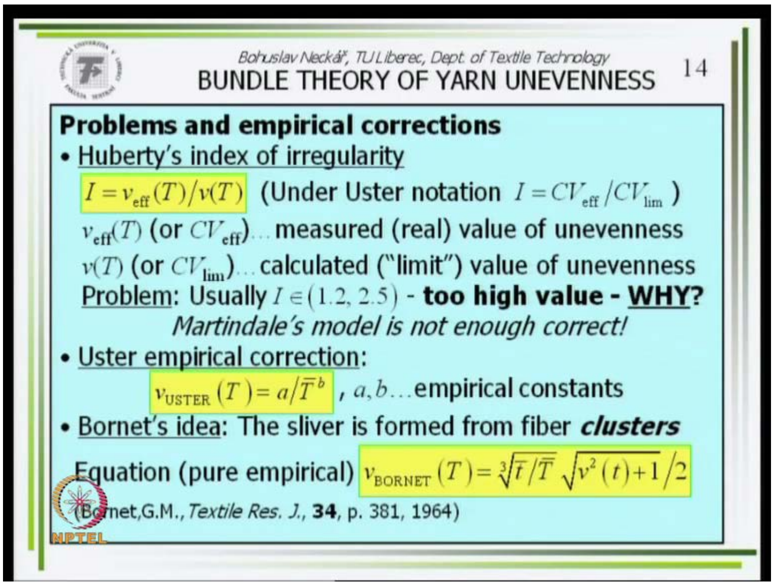

The question is why - the question is WHY it is because exists something. So, some or institutions make some empirical corrections for example, so calledUsterpreciselycompanyin the Swiss land in a town name Uster but, it is known as Ustermeans andUstercompanythey useforcoefficient variation oflocal Sliver fineness. When I speak about the Sliver is a little theoretical practicallywe use it at most for Yarn on. So, something like some Sliver from fibers.They usesuch formulabecauselogarithm of this is straight lines and you know the graph fromUsterwhich have the trend to be straight lines.

Interesting workis that the 1964 fromBornet which formulate the idea why the real Yarn irregularity is higher than the calculated value based on Martindale's concept, is meaning that, as it is because fibers are not individual than in some bundles for similar aggregates.

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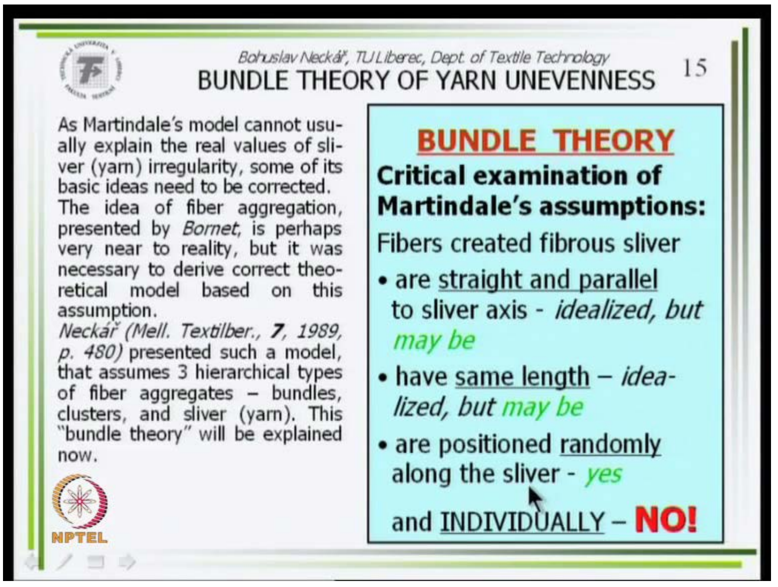

Nevertheless,it is verbal; nevertheless then he used quite empirical equation which is this here. Weaccept generally the idea ofBornetthatthe influence the center of influence is in some fiber aggregates and in opposite to him we derived the model exactly. So, let us think at first step about the Martindale'sassumption.Martindale used the assumption of fibers are straight and parallel. It is idealized we can say that yes is idealized may behe assumed fibers havesame length; you can say also idealized here – why? May not, may be fibers are positioned randomly along the Sliver; it is evident but, he assumed also and individually and this is not right. Wehave enough experimental results too in general work that the fibers are not perfectly one beside the other, but they are moving together in some fiber aggregates.

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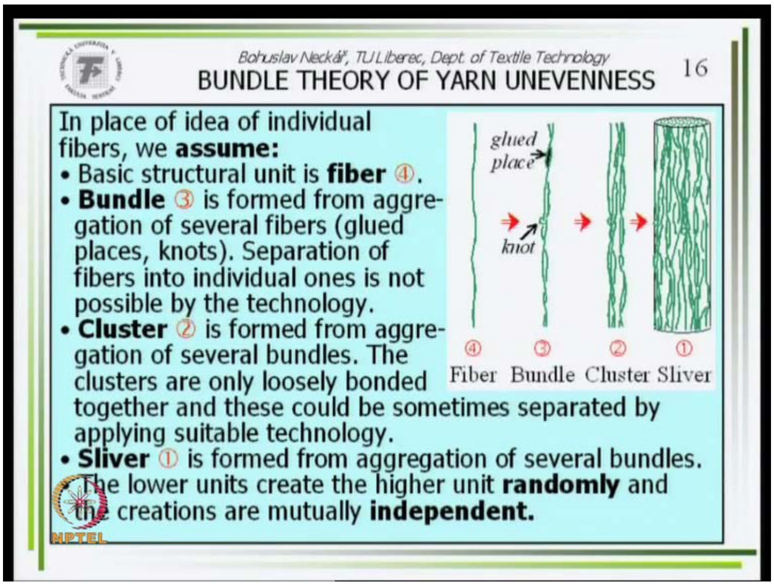

Therefore, we created the following model based on the idea which is shown in our picture. Thebasic structural unit is a fiber this here from fibers is formed a Bundle a Bundle it is an aggregation of several fibers which are together glued or knots. So, that the separation of fibers in the individuals ones is not possible by technological process used. So, they of they function as a for example, couple ofsuch fibersfunction as 1 thickfiber this is the bundle. From bundles are created clusters. Cluster is formed fromaggregation of several bundles. Theclusters are only loosely bonded together and these could be sometimes separated by applying suitable technologies. Bundle is too infinity for us made the fibers together.

Cluster is possible sometimes based on thelocal relations in technological process divided to smaller clusters or not. Based on the situation what we do in spinning mill for example, this is a Cluster and then the Sliver or Yarn. Finally, it is formed from aggregation of several bundles. Thus, from this unit you obtain the final structure Sliver the lower units create the higher unit randomly and the creation are mutually independent. Theyare our assumptions difficult in short timeto havebecause it is not practically possible to each quantity as subscript right fiber Bundle cross the Sliver thenwe use numbers which is related to fiber is 4 - number 4 which is related tohard bondedbundles is number 3 which related to clusters is have number 2 and which is related to the Yarn or fiber have the number 1.

So, 1 is Yarn 2 is Cluster 3 is Bundle and 4 isfiber yeswe imagine that we create from fibers number 4 bundles number 3 then from bundles we createclusters number 2 and then from Cluster we create Sliver or Yarn cross section number 1. In reality it is in opposite we have some material and the this material we dividetoclusters bundles individual fiber. So, on,but let us imagine this structure this is our idea.

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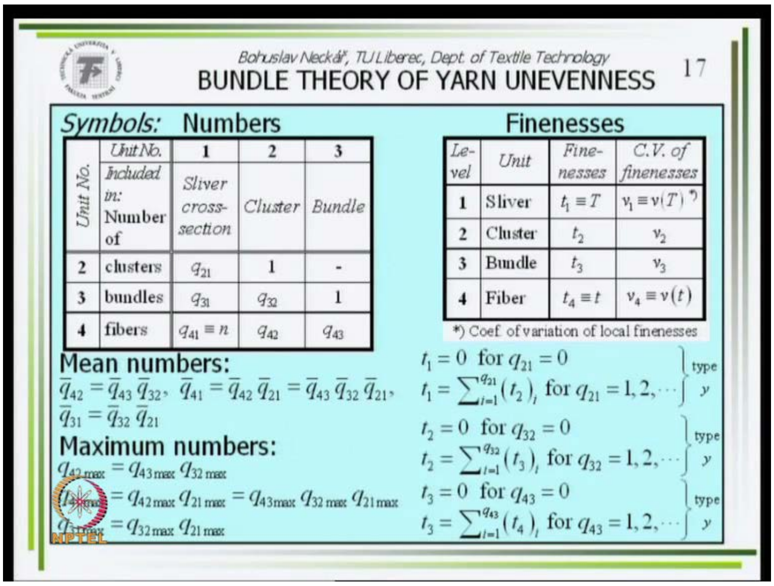

Now, the quantities number of the smaller parts in higher unit. So, that a numberof clusters in Sliver cross section equal q 2 1 2 is Cluster 1 is Yarn or sliver. How many clusters in the moment is in Yarn or Sliver cross section, number of bundles inthe Sliver s q 3 1, number of bundles in yarn? So, and number of fibers in Yarn cross sections or Sliver cross section it is q for 1 fiber Yarn.

Our all the symbol was n number of fibers in Yarn or Sliver cross section number of bundleswhat is the numberof clusters in Cluster evidently 1 how many Cluster in cross is given Cluster 1 number of Cluster number ofbundles in Cluster is q 3 2; bundles in Cluster Bundle is 3 Cluster 2 it is been necessary to use thissystem of subscripts and so on.

Where is the numbers of smaller parts? Inhigher unit evidently, it is valid equations for mean numbers for example, here near mean number of fibers in Cluster is mean number of fibers in Bundle times mean number of bundles in Cluster based on such logic all this equation must be valid.

The same is maximum numbers; similar equations maximum number of fibers in Cluster. Itis maximum number of fibers in Bundle times maximum number of bundles in Cluster, no it is logical; on this logic all this equation are constructive. So, evident that it is valid. Now, to fineness finenesses Sliver fineness we call in the moment t 1 our other our othersymbol was capital t.So, t 1 is same than earlier capital tco efficient variation of Sliver localfineness is v 1 why 1 because structure number 1 Sliver early it was v capital t.

Clusterfineness of the Cluster is t 2 coefficient variation of this is v 2 coefficient variation of fineness of clusters Bundle fineness moment the moment fineness of a Bundle some Bundle is t 2 coefficient variation of finesses offrom or bundles is v 3 and finally, fiberfineness is t 4 fiber have subscript 4 it was identical as earlier small t and coefficient variation of fiber fineness is v 4 identical of earlier symbol v t.

What we can write now? Finenessof the Sliver or Yarn is 0; if number of bundlessorry, if number of clusters in the Yarn is equal to 0 no wonder andfineness of Sliver is some offineness of all bundles inclusters in all cross sectionfrom first to last. So, that it is this way. But what is t 2 this fineness of Cluster is equal 0 if no fiber is there the number of Bundle is 0 and thesimilarly sum of all finenessof bundles over all bundles which are in the moment in cluster.

The same what is the fineness of Bundle 1 one from fiber from fibers it is 0 if no fiber and it is sum of fineness of fibers or all fibers in Bundle let us see this structures this and this all these 3 quantitiest 1 t 2 t 3 are random quantities likewise we make in last lecture some small excursion to theory of probability when you find somerandom quantity type y and wepostulate how itscoefficient variation of such random quantity. All the 3 all the 3 are quantities type y.

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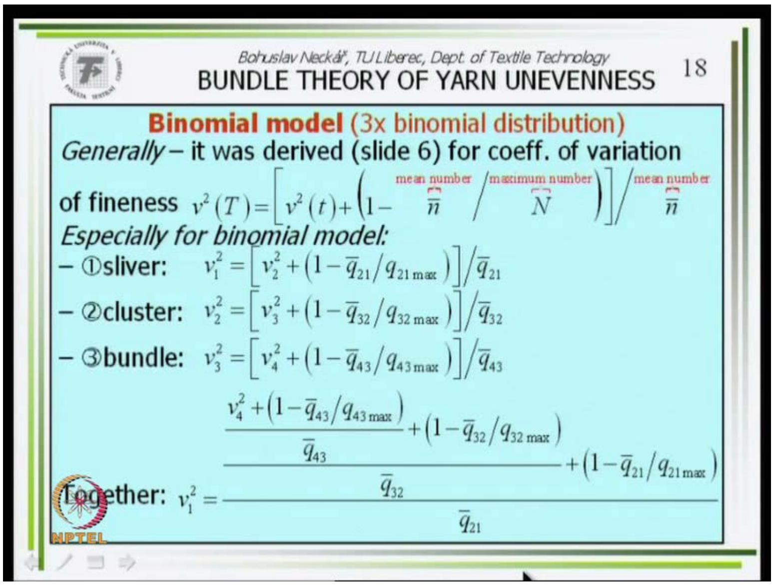

Let us imagine now that each quantity t 1 t 2 t 3 have a it is random quantity and have the binomial distribution now identical, but all 3 are type binomial distribution therefore, in short here 3 times binomial distributions. We definesuch equation using this type ofexpression what is this it is mean number bar by maximum number and this is divided by maximum number now for v 1 square based on this formula.

For v 1 square we obtain this equation mean value maximum value for v 2 square we obtain such equation similarly and for our v 3 square we obtain this equation the way how to obtain it I think clear yes. So, how it is v 1 square v 1 square it is this here, but on the place of v 2 square I can use this expression.

So, it iswhat it is by qbar 2 1 and here is plusthis brackets you here plus and on the place of e 2 square I use this expressions. So, it is this here it is bar q bar 3 2 and. So, seemly, but here is v 3 square and otherwise of v 3 square I can use this expression it is here.

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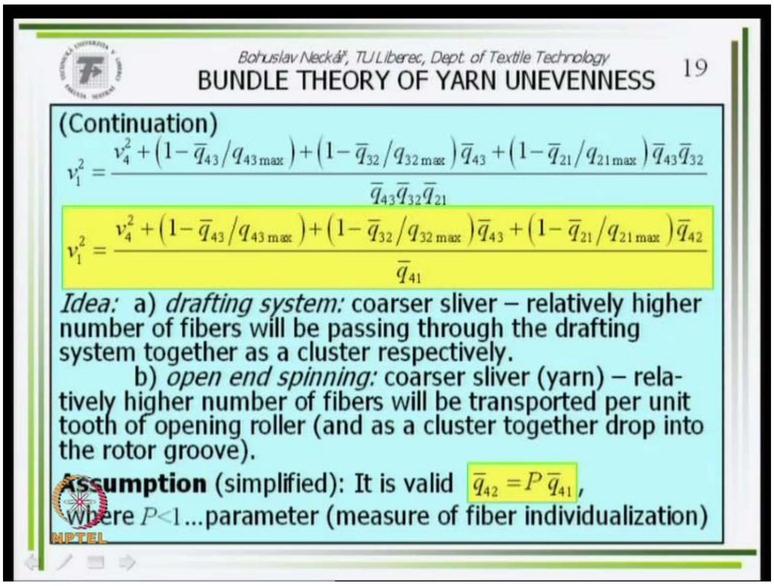

Coefficient variation of Sliver v 1 square of it is given by this expression after rearranging th obtain is here after rearranging and using equation postulate earlier we obtain we go for this q bar 4 3 times q bar 3 2 times q bar 2 1 isq bar 4 1 it is written earlier where it is for example, here it is in some in some expression it is here. So, so that we obtain this expression for Sliver local coefficient of variation and now let us accept 2 ideas the first thiswhen youproduce ring spun Yarn for example, then the drafting system on the ring frameconvert is a Sliver or finest Sliver based on count of final yarn.

Relatively higher number of fibers will be passingthrough the drafting system together as a Cluster respectively when we producea coarsen from a little coarser Sliver because more fibers in the drafting part of ring spun ring framewhen in another process rotor process rotor spinning relatively higher numbers of fibers will be transported per unit tooth of opening roller when we produce a coarsen orwe use coarser sliver.

So, that when we produce Yarn having more fibers in the sectionmay be the number of clusters which are created earlier is higher and vice versa. So, therefore, we can postulate or say some assumption of course,it is some simplification that number of fibers mean number of fibers in 1 Cluster is proportional to the number of fibers in Yarn process section and improve your coarsen the number ofthe number of fibersis cross section is high and therefore, all of the clusters which are created are this Yarn will bebigger. So, that you can writeq 4 2 bar is p times q 4 1 bar in our relation where the parameter p is a parameter of proportionality and it is if they have some sense it is a measure of fiberindividualization. It means if p is small then number of fibers in our Yarn is created fromclusters having small number of fibersif p is high then vice versa our clusters we have lot of fibers think about this phenomenon we will use this equation in our in our equation for v 1 square.

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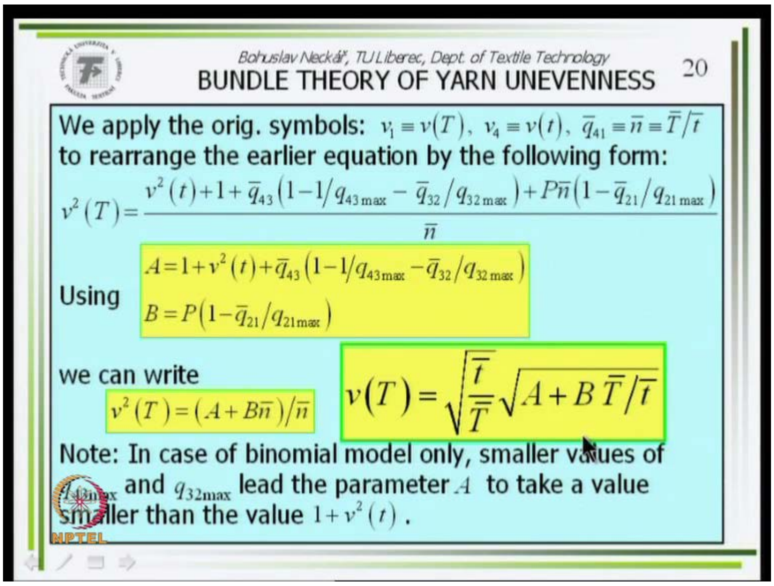

In the same time nowwecome back to our traditional symbols as possible. So, that on the place v 1 v is back v t on the place v 4 v small t on the place q bar 4 1 number of fibers in mean number of fibers in Yarn of fibers cross section small n bar it is t by t and so on.

Using this substitution plus this assumption we obtain such equation and symbolically we can write that this part have the name a capital andsorry, this our part here renamea capital a andthis partp timesthe p timesthis here. It isit isquote and the symbol B when a is this here and B is this here we obtain coefficient variation and this from as and if n bar is T by TT bar by t bar worked in the final equation in such form.

It is a difference between, in relation toMartindale's equations because we are here the part B which we write it is which is multiplicative when number of fibers generally say weit is also theoretically possible in this moment that 1 plus v v square t i can be smaller than it can be higher than our part a theoretically can be. So, that theoretically we can also to obtain theunevenness or you know irregularity similar than limit value based on binomialsliver. It is only theoretical example in the practice nobody watch it, but theoretically it is possible more easier with this when we use for us easierdistribution when on the place of binomial wegive the Poisson distribution we derived it by Martindale’sconcept.

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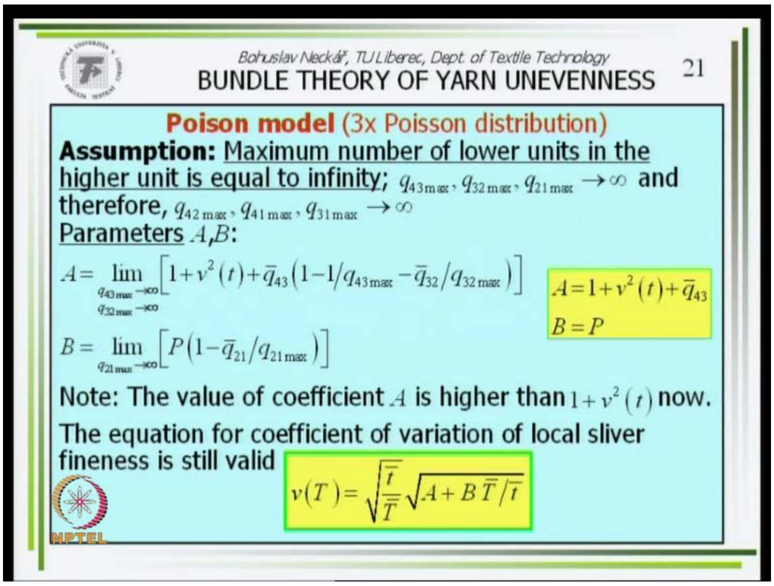

What isin the Poisson distributions also 3 times of coarse distribution of fineness ofbundles clusters and yarn, but e type for each this Poisson distribution.

Then in Poisson distribution the maximum number of possible cases is limited to infinity isn’t it. So, that by Poisson in Poisson version q 4 3 max as well as q 3 2 max as well as q 2 1 max is limited to infinity then our part a using this limit have this form you know have this form and our part B after this limitingis equal to p a parameter which say us something about the I mentioned it where measure of fiber individualization isnot it.

So, on the formally the final equation stay be same have the same shape by the by what is more what is more in relation to Martindalehave here 1 plus v square t now we have here plus q bar 4 3 number of fibers in Bundle itmeans in a in a structure in which the fiber stay fixed together glued knotted. So, that is it. So, that it is not possible to our technologies toprocess itdivide.

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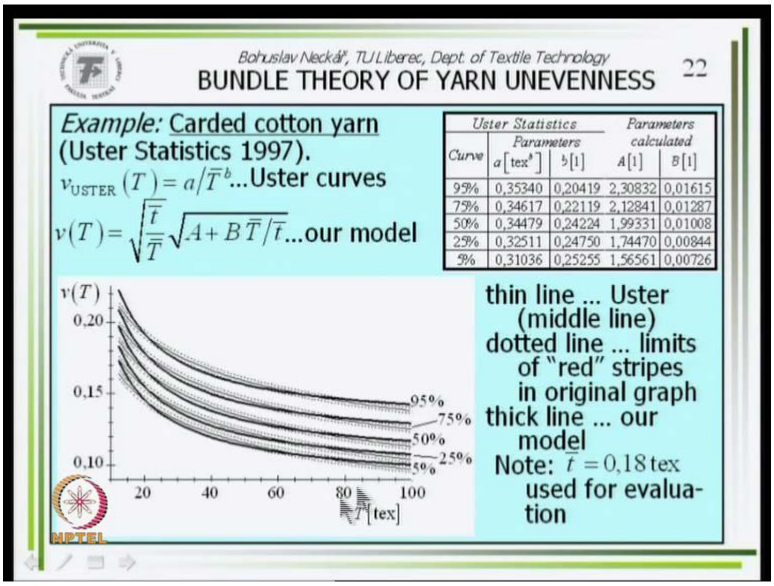

Yes how is the practical result it is another experiment because earlier it is better for us thantoday's the lastvariation fromUsterstatistics why in the modern spinning process the draw framesare used thissome mechanism of regulations they can very intensively regulate the irregularity orthe unevenness of Sliver therefore, also the Yarn have smaller values

We studied this Yarn unevenness as a pure random process with some standard regulationof reasonthat for I usethe result as an example result fromstatistics 1907 1997.The basis may be the graphical explanation on the on the abscissa here is mean Yarn count it is for Yarn carded cotton Yarn count in tex is here on the ordinate it is coefficient of variation according coefficient of variation of local Yarn fineness Yarncount.

TheUsterreserves are the thin lines here you know thisUstergraphs, but now it is not linear because I have linear the abscissa scale this scale can be abscissa here is linear. In its standardUstergraph this abscissathis graphic symbol logarithmic therefore, in some logarithmic graph or logarithmic graph if you obtain linear relation graphically this result logarithm therefore, theUsterresult are the thin lines here and because you knowUstergraphical interpretation, they use little thick red lines I showedalso dotted lines how is the thickness of this red line in the pictures fromyes.

Using our equations and having two 2 parameters a and B suitable parameters we obtain the thick curves here set of thick curves. Hereyou can see that inpractical used region our curves are linked practically inside of thickness ofUsterred line.

So, our model can very good to approximate or no approximate to interpret better the experimental results published byUsteryes therefore, because this influence because this bundles and so on. Thereal unevenness is higher than the ideal unevenness according Martindale.

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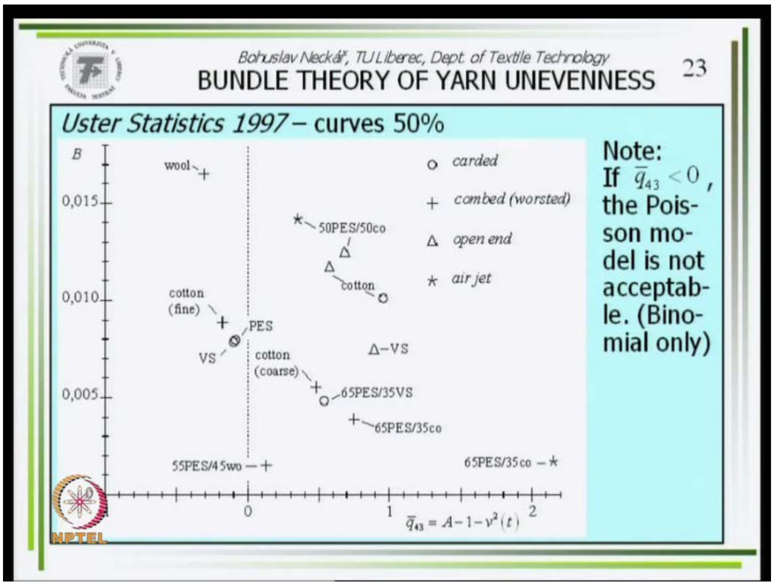

Here some for 50-50percentageUstercurve 50 percentagesome graph which show how it is in different types of yarns here is q 4 3 as a function of as awhich is a minus 1 minus v square t andq bar 4 3 it is a how is the number of fibers mean value of numbers fibers, in the fiber bundle do not worry, but it is starting from 0.

We speak about the Poisson distribution. So, Poisson is, in Poisson distribution also, number equals 0 is possible as far as the binomial distribution only in re Yarn when we have some part of fiber in which number is 0 then it is breakthere is some knot here.

Therefore, it is going from 0 in a special in a cited where it is in a cited publication inhere it is the publication in which it iswritten in more details. Itis shown how it is non break Yarn, but what isinterestingfrom thistheoretically it is possible to apply Poisson model;Poisson’sdistribution onthese are on the left is not possible.

It must use binomial distribution. So, you can see that this side the Poisson distribution can be used for each Yarn is model we can formally use this, but we do not obtainrelation to the model right resultsyou can also see that the parameter B and a aredifferent type of yarns and we will on the times see watch this diagram you can see that it isfor example, interestingdifferencesbetween ring Yarn and rotor yarn.

In rotor Yarn the Cluster the number of fiber in Cluster are relatively small as shown this experimental experiences the values hereare relatively small smaller than in ring Yarn another thing is the bundles this smallernumber of fibers in the Bundle is higher. Please do not imagine number of fibers inbundles is not too high value it can be 1.7 for Rotarian example or 1.3 1.2 number of fibers it means sometimes 1 fiber sometimes 2 fibers together sometimes 3 fibers together and 4 fibers together is a chance as in lottery.

Imagine so, but it can play very significant role for unevenness herein Rotarian theCluster the Cluster is from is from small quantity of bundles, but the bundles arefor example,1.8 fibers mean value of fibers in a position to ring frame on which we obtain 1.1 or 2 something. It is in a rink Yarn; it is vice versa in rink Yarn because drafting process make the fine Sliver which is twisted and because drafting processtheCluster have the tendency be have more bundles bind in Bundle isonly a little more than 1 fiberfor its 1.1 1.2based on our experimental.

So, that you can see that we can also divide we can also divide the 2 influences 1 influence is the fibers arebased on another technological principle permanently together glued knotted than this and the secondthe no clusters which can be when our process is good can be divide and it bringus when we analyze our data from industry based on this it is theoretically it is very easy because these equations are the these equations is awhat is it is a linear equation oryou can use thelinearised statistical regression and from set of data, I do not know from your spinning mill to obtain the parameters a and B for your Yarn it is evident.

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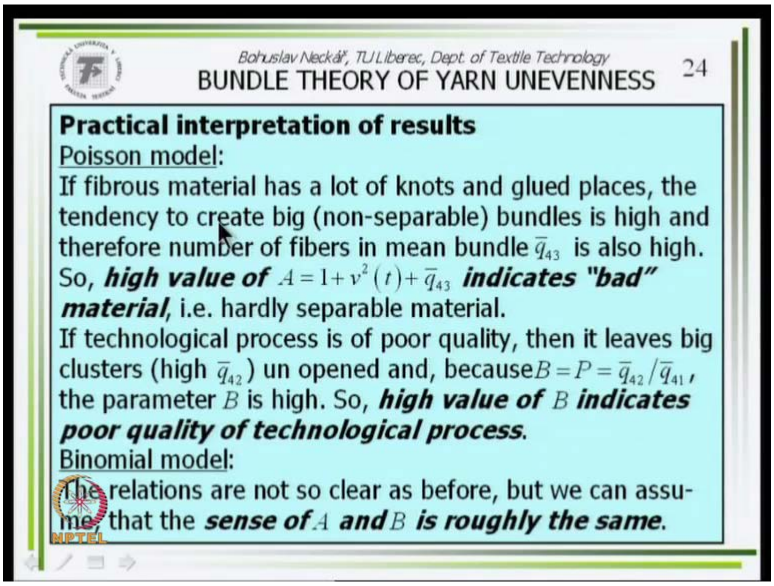

Now, when a is tooyou now you have some Yarn which is not good the irregularity is too high based on thisanalyses or you can compare you can compare your data fromwhere's I do not know that the data which are here for example, for fromUsterand when a is too high when a the quantity ais in your yarns too high what it means a is in the case of Poisson distribution 1 plus v square t this is a Martindale, but plus q bar 4 3 number of fibers in our bundles whenyou have too much fibers in bundles knot, do notbe distracted bybundles. What you can do? You can try only. Youcan try and you can find on the market another type of material which have knot so, intensive tendency to create such bundles because, this is the influence of the material.

When you will leave, butvalue of your Yarn unevenness andbased on this analysis you obtain to them that B is false. B is by Poisson's model equivalent to p.Then, no forces sorry, that p istoohigh; it means you have too big you know,these bundles than the clustersour clustersyou have 2 bigger clusters. Then, what can you do? Because, to obtain better unevenness, big fight in your spinning mill all people must watch why we mustrearrange machines - the carding machines; the surface of the of theall cylinders must be sharp the all this rearranging of machine machines must be optimum and so on.

You can start to make some big fightin your spinning mill; in the firstcase not in the first case, you can only try and/or findon the market another type of your I do not know cotton fibers which have knot; so, high tendencyhave 2 fibers together.

In the second case, you must organize some symbolicbig fightin your spinning mill and there is a practical endfor our theoretical model. Principally, we use the same idea - the Martindale nevertheless.

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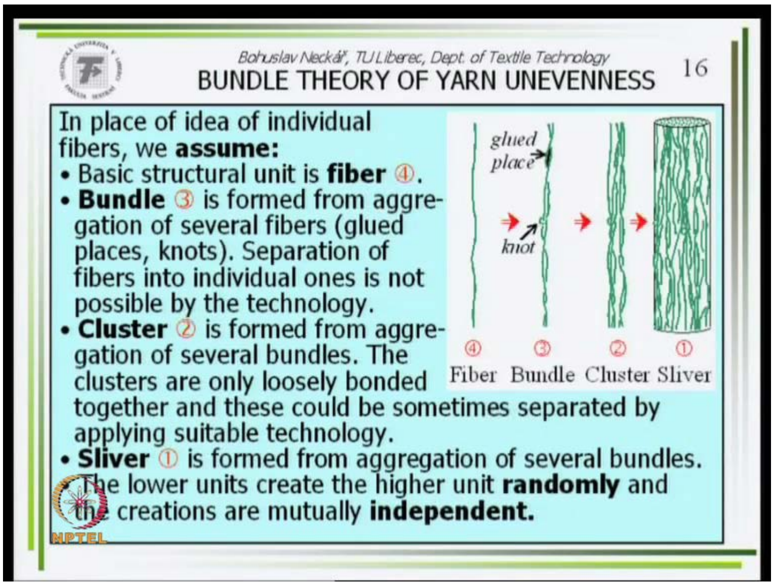

Weapply it to more general idea; you know from individual fibers immediately yarn. From individual fibers we createbundles; from bundles clusters and from them, clusters the Yarn; these are the difference - logical difference to Martindale. Youcan say how we obtain this system? Itwas worked and my first version of model was only 3 steps from fibers to clusters and from clusters toyarn.

But, when I compare it with our own experimental research as well theUsterdiagrams and specially forthisfinepart of the Yarn, it wasnot, thecurve wasnot enough precise; wasnot enough. Well, I think what is the logical sense ofthis?Nogood results in one part of the case and we cameto them that logically it must existsomething like this bundles, some fibers, some fiber bundles which are based on our principle use technological principle usedpermanently together; not possible to divide and then finish our lecture.