Computer Integrated Manufacturing
Professor Janakarajan Rajkumar
Department of Mechanical Engineering & Design Program
Indian Institute of Technology, Kanpur
Lecture No 28
Group Technology and Computer Aided Process Planning

Welcome to the next important Vertical in this course that is Group Technology and Computer Aided Process Planning, as the name clearly insist that, it is called as group technology that means to say you are supposed to group something together based on some similarity. So, what is that similarity as far as a part is concerned; it can be shape, size, or the manufacturing process.

So, grouping parts, similar to features what is there in the product or in the part is nothing but group technology, this is very, very important, because as and when a part enters into a factory, or into a design, we have to give a number to it. How are we going to give a number to it that is what we are going to see in this Group Technology.

After understand the concept of group technology, we will be moving towards process plan and where in we will see manual process plan, and today because of the advancement in computer, how computer is getting integrated into process planning today. Computer aided process planning is a very important topic, because this is what going to club between a CAD and a CAM environment. CAD is basically a designer who draws, it can have conceptual, it can have embodiment, it can have detailed design.

Now, after that, when it has to go for manufacturing, computer aided manufacturing, it has to have an interface, which understands the drawing and converts the drawing into some form such that it can be produced. So, that interface will be done by a process planning and we will study here, how computer is helping in process planning, because this course wholly goes around computer integrated manufacturing, how do you integrate computer into mass production, into mass customization, into batch production. So, that is what it is, so this is a very, very important topic.

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So, the content of this lecture will be, first we will try to see what is group technology, then naturally the benefits or the advantages of group technology, we will see what is a part family, then coding system, and limitations of group technology. Part family those who are studying science, they will really appreciate, they in Botanical studies you have so many plants.

Now, all these plants, what we do is, we try to group them under some commonality and that common name is given as family. So, in the similar manner, the manufacturing industry also has taken the logic from Botanical scientist and Zoological scientist, they have come up with how do we make families, such that we can integrate, so different, different versions of parts into one grouping and then start understanding the grouping.

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So, what is group technology? Group technology is otherwise called as GT, is a manufacturing philosophy in which similar parts are identified and grouped together to take advantage of their similarity in design and production. Similarity in design can be size, shape. Production can be a manufacturing or a machining process.

So, here group technology is to identify and group together to take advantage of their similarity in design and production. Group technology contributes to the integration of CAD, Computer aided design and CAM, Computer aided manufacturing, this is what I said, this is going to bring in this group technology is going to bring in a seamless connection between CAD and CAM.

Similarity among part permit them to be classified into a part family, this is what I gave you an analogy of botanical families and zoological families. They look into the similarity, whether the animal has four legs, two legs, mammals.

So, they put under families, why? Because once you put them under a family, you can generalized and talk about their family characteristics, same way here. In each part family processing steps are similar. The improvement is typically achieved by organizing the production facilities into manufacturing cells that specializes in production of certain part families.

So, you have grouped those families in botanical studies and zoological studies, based on some similarity. So, here also, we will do either with size, shape, or in terms of manufacturing, why is

this very important? Suppose let us assume, you are trying to find out a new plant, a new animal, or a new product, coming into existence.

Then what you do is? You have to quickly grow, cluster them and put them into some family, why is that important? Because once I know they belongs to this family, there characteristics, their machining process to a large extent I can understand. And this if I have to automate, it becomes very easy. So, part family is a very important thing, which is done under group technology.

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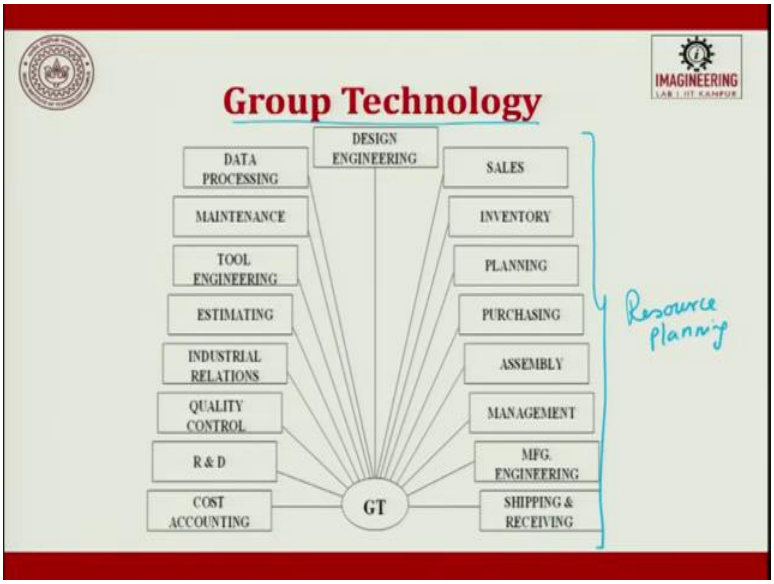

So, group technology has all these things integrated into it, it takes costing R & D, quality control, IR Industrial Relations. Estimating, either in terms of time, or money, tool engineering, where in which we talks about gigs dice, fixtures, then gauges for measurement, maintenance predictive maintenance, preventive maintenance, data processing, design engineering, we look into sales, all these things get input from GT towards that.

So, sales, inventory, planning, this side is completely resource planning. So, all these things get input from group technology. So, planning, purchase, assembly, management, manufacturing engineering, and shipping and receiving. So, all these things by enlarged try to get information from group technology.

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What are the benefits of group technology in manufacturing, it allows similar design to be easily modified from the existing design. So, if there are some 6 people, so all these 6 people, if you want to find out some similarity amongst them. Suppose you have a class of 40 students and you want to talk about the class. So, if you want to talk about the class, one you can talk in terms of health, then you can talk in terms of IQ, then you can talk in terms of EQ.

So, when you do that, what you do is? You conduct an exam normalize it and then you try to figure out, what is the strength of that particular students in that class. So, then accordingly, you can put a teacher who can teach them and try to improve, what is missing with them fast. So, that is what is done here.

So, it allows similar design to be easily modified from the existing design. So, there is lot of data, you are trying to group something common datas into one family, from the database instead of starting from the scratch. I told you example a new part comes inside, a new plan comes inside, then how do you classify them and how do you talk about their characteristics.

Standard process Plan can be develop from the grouping, once you have group them for after grouping them I can have a strategy, such that these are the process which are to be used, If the data is like that, that is what if you go back to a similar analogy of a classroom once you know the classroom is lagging certain properties or certain intellectual capabilities, then you appoint a teacher to cater to those only.

And then uplift them, but whereas when you to try to talk about in manufacturing, what we do is, we tried to make a standard process for them, moment you standardized a process, then for that standard process of establishing a layout inside your factory becomes very easy. So, grouping those machines become very easy. So, once you group a certain machines, then manning those machine becomes very easy.

So, we will always look for standard process plan, so that comes out of group technology, then great efforts can be applied in optimizing the process plan, optimizing process plan is very important, because you can now quickly take a stock, what is the raw material required? What is the shape of the raw material required? What are the tools required? And what are the dimensions of the tools required?

So, process plan can be optimized, then tooling and setups, standard tools can be developed, then allows faster production, therefore lesser inventory, and work in process, the throughput time can be reduced to a large extent, material handling and movement is also reduced, moment you know that these are the machines to be used.

Now, I will arrange those machines in a particular fashion, such that the material handling becomes very easy, see when you talk about big industries, where there is a mass producing, a batch production industries, material handling is a big challenge. Can I move part by part can I move 30 parts, can I move 100 parts, can I move 1000 parts, it all depends for example when we try to take a soft drink, which gets which gets transported from the wholesaler to a retailer.

Now, it depends on what is the packaging you do and now how do you handle the packaging. So, material handling is very, very important and movement is also unnecessary back and forth movement is reduced, because any movement, which is redundant in the factory is going to put a cost on the factory, for all these things, group technology comes up in a big way and gives a big shift in productivity in the manufacturing scenario.

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Apart from those benefits, it also tries to improve the quality and reduce a scrap, utilization of the machines have been increased, floor space available is also increase, increase in the output per employee is also done, then manufacturing lead time is reduced, then you will have improved ability to respond to customer to market.

So, the agility, depending upon the market requirement, variation in the product can be done very fast. So, agility can be done, job satisfaction is done and greater management worker harmony can happen. So, all these things predominantly goes to the benefit of group technology.

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So, group technology implementation can be split into 3 phases, first, action on the manufacturing process will be the first phase, changes to the production process will be the second phase, results for the organization will be the third face. So, these are the 3 different faces, which all happens during the group technology implementation in a factory.

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So, when we talk about group technology, the following actions on the manufacturing process has to be done. Part simplification, process standard, and production control, 3 important actions are

to be taken. Parts simplification, suppose if there are variation, if there are 100 number of variations. So, what we do is, we try to simplify and try to make the part geometry, modular and simple. And what we do is with that simple thing, we will see how do we functionally meet the requirement, which is expected out of the product?

Next we tried to process standardization we try to do it, rather than doing everything on a fire fighting mode and erratic mode, we establish a standard procedure and follow it, for example between one machine to the other machine, 50 parts is the minimum size of batch size which is to be moved, then for example the layout of the factory can be standardized.

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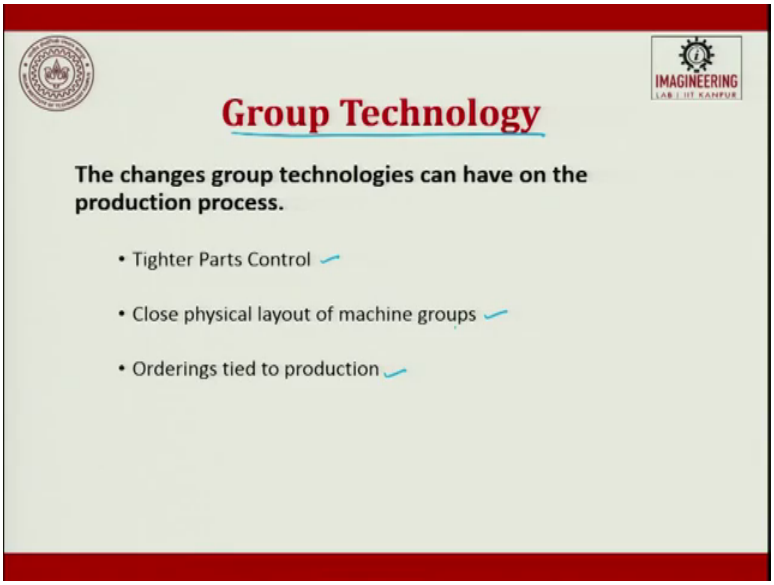

Next the production control, the changes group technology can have on the production process are tighter part control, close physical layout of machine groups, ordering tied to production, all these things can be done, if group technology is implemented in a strong manner. Tighter part controls can be done, close physical layout of the machine groups and ordering tied to production can happen.

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So, different impacts group technology has on the production process, it reduces purchasing cost, redundancy see is reduced, accurate cost estimation can happen, quicker design changes can happen, because you have standardized the part. So, when there is a small change, you have to do some modification on the standard process plan, improvement in the customer satisfaction, because you have reduced the lead time.

So, classification build customer relationship can be done, these are the different impact group technology has on the production process. If you go back we have seen what is the group technology implementation in 3 different phases, action on manufacturing process we have seen, changes in the production process.

And let us see the results that group technology have at the organization level is systematic design and redesigning can be done very fast. High quality level can be maintain, lesser process planning time and setup time will be there, because there is already a standard process had laid in front of you, all you have to do is, tweak that little bit up and down and then you get to the matching output.

And interestingly many of the hotels, star hotels, follow group technology, they try to classify and put the proprietor items in a readymade fashion and they have a standard procedure, they just follow the procedure to get the output, whatever you want, and they also follow a modular concepts so that they can need out to lot of customers.

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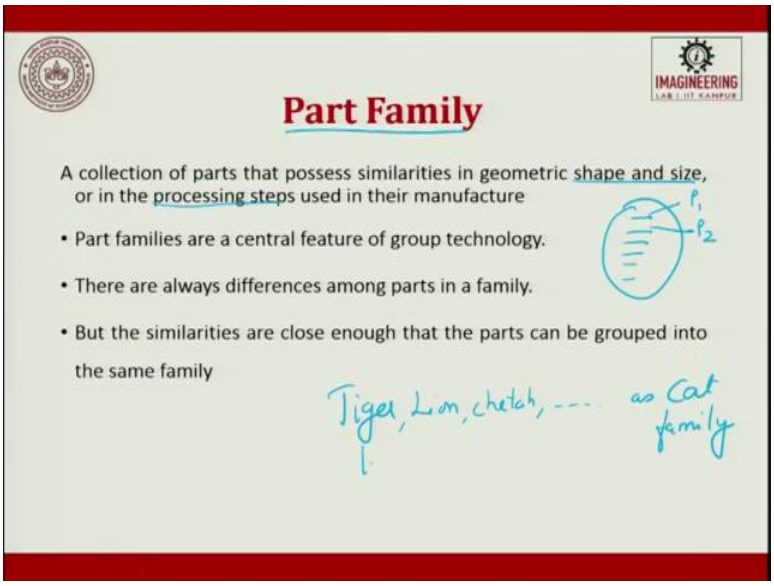

Now, let us go into the part family, a collection of part that possess similarity in geometric shape, size or in processing steps used in their manufacturing is called a part family. A part family are a central feature of group technology. There are always differences among the parts in a family, one family parts, there is a difference between P1 and P2, but they are altogether, for example, all cylindrical parts as 1 family, the diameter can change, the geometry can change, you can have a step, it can have a thread all these things, part to part variation is there.

But overall there are some similarity, but the similarity are close enough, that the parts can be grouped into a same family. For example, you look at zoological family, which I was always telling, we call Tiger, Lion, then Cheetah, et cetera, et cetera, as Cat family, look at it, 4 legs are there, and we put all of them, they have a tail all of them. But individually, if you see all this fellows have different, different, difference in their variation. So, family is some similarity, but part to part you can have variation.

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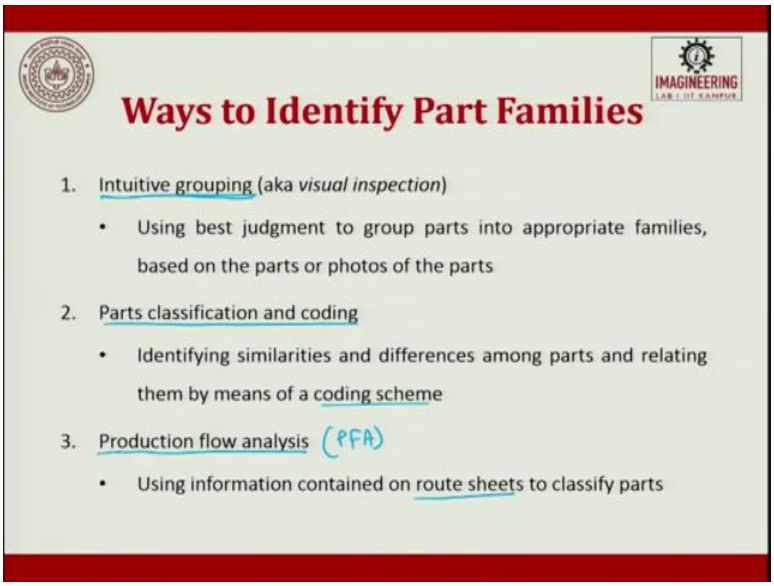

What are the different ways to identify part family? First is intuitive grouping, using best judgment to group parts into appropriate families, based on the part, or photo of the part, this is the first way of identifying a part family. The second way is part classification and coding, the third one is going to be production flow analysis.

In intuitive grouping, we try to judge a group of parts into an appropriate family based upon the parts. Then part classification and coding, the second way of identifying the family, identifying similarity and differences among parts and relating them by means of a coding scheme is part classification and coding. The last one is using information contained on root sheet to classify into a family.

So, this is called as production flow analysis or PFA. So, these are the ways of classifying a part family, first one is you look at the part, you know, okay, there are similar, so then you try to do by visual. Next you have established a set pattern of coding, look into it where does it form, how does it form, and then you classify. The last one is based on, some manufacturing process.

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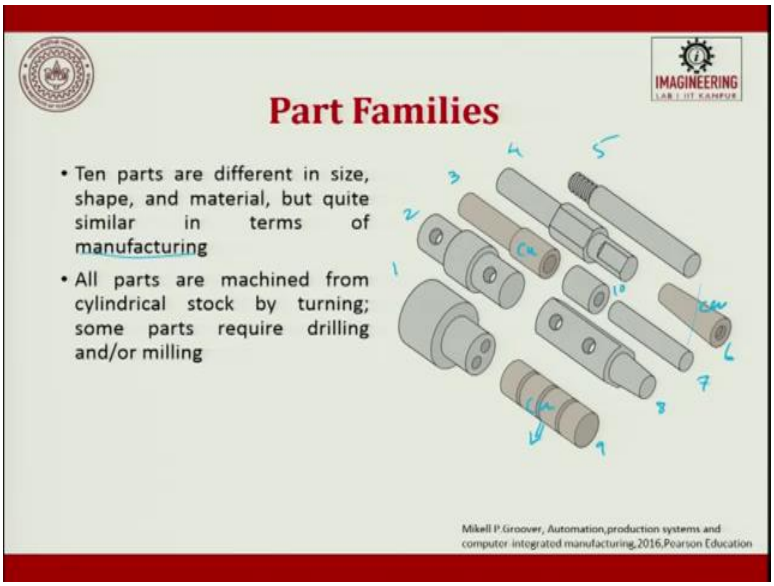

Part Family, ten parts, these are 1, 2, these are different, different parts, we have seen it pretty interesting or I have put 10, here is a tenth fellow a short fellow. So, you look at it, all of them completely various right. So, there are 10 different parts, their sizes are different, there shapes are different, there features are different, but you can still classify it under 1 family, what is that? They are all circular.

So, now for doing all these parts, what you need a machine is minimum a lathe machine, then in the lathe machine, you can try to have holes made, grooves made, taper made. So, all these things can be made in a shaft. So, if you want to make a hole, completely drilled hole, then after this lathe machine, you have to go to a drilling machine.

Then when we have to flat surface on a cylindrical surface naturally you need a milling machine, or the 10 parts are completely different, but they are classified under 1 group called as, maybe I can call it as, a turning group, every part can be made in a lathe machine or in a turning machine of a CNC. So, here if you see 10 parts are different in size, shape and material, I have not talked about the material, assuming that let us assume these are different colors.

So, this is copper, this is copper, this is copper, rest all are aluminum or steel, but the part family does not look at the material at all. So, the 10 parts are different in size, shape, material, but quite similar in their manufacturing process. All the parts are machined from a cylindrical stock by

turning, some parts required drilling, some parts required drilling and milling, or only milling, after turning. Here is a part family, this is all a part family.

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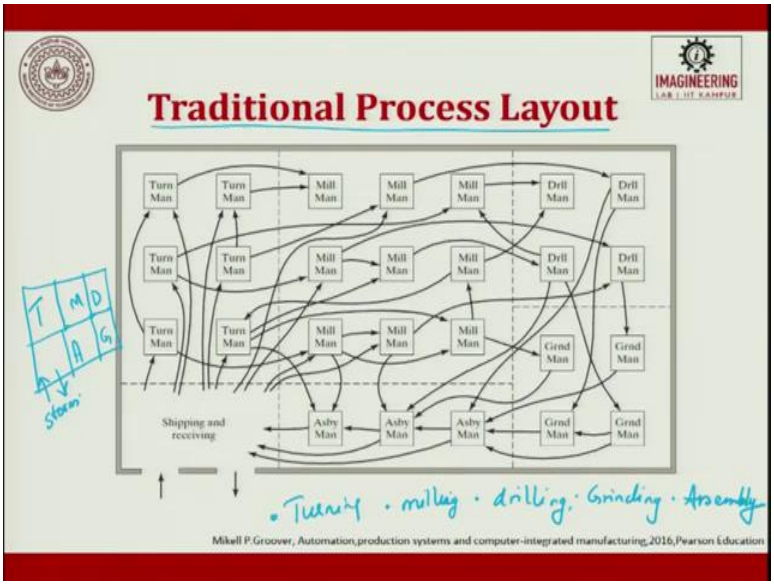

So, traditional process layout is also there, so what happens is, you see there, there are turning machines, there are milling machines, there are drilling machines, there are grinding machines, and of course there is a assembly, correct? Turning, milling, drilling, grinding and assembly, all are there. So, now in this what happened? The part tries to flow from turning to milling, milling to drilling, drilling to grinding, and then it comes to assembly and then goes out.

So, here if you see the machines are grouped based upon the similarity in the manufacturing process, if I draw and if I want to write the entire thing into different work centers. I will just write it like this, turning work center, milling work center, drilling work center, grinding work center, assembly session, in and out of or I can say it as stores. Now, I have grouped them based upon the similarity in their machines right. So, this is the traditional process layout.

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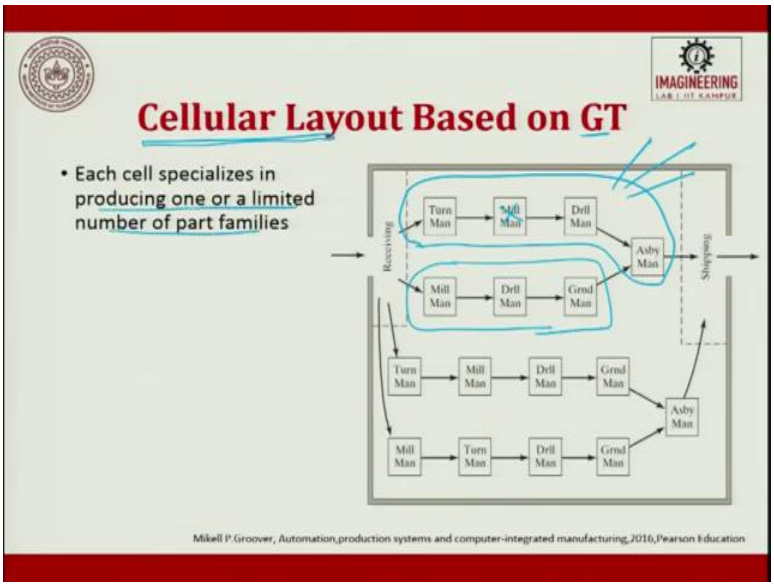

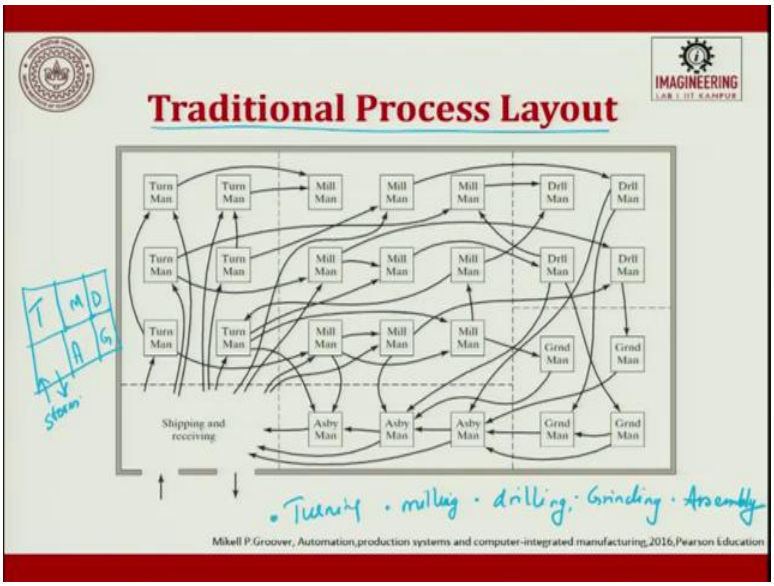

Now, when we talk about cellular layout based on group technology, if we go back and see there is a zigzag or back and forth movements of materials, which goes between machine to machine to meet out the output. So, now what I have done is, I have wisely made several groups, so what I have made is, the grouping is being made depending on their part family.

So, this is 1 group, so where in which you will have turning machine, milling machine, drilling machine, and an assembly station. So, you will have a second group, where in which you are turning machine is removed, you will have milling, drilling, grinding, leading to an assembly. So,

here what I have done is? Depending upon the part, there features whatever is there I have developed a layout, I have developed a layout. So, based on the layout how I have done, looking into the part.

So, now the parts, the machines are grouped depending upon the part. So, here this is called a cell layout, so basically like your cell phone, we call, we also call it as a cellular layout. In cellular layout, the grouping of machines have happened only in the fashion that what are all the parts which can be made, which is different from the previous slide, in previous slide, we have grouped all the machines which are similar, each cell specializes in production, in producing one or a limited number of part family.

The another big advantage is, suppose if you have established 3 lines like this of the same group of the machine, 1 machine comes off, the other 2 groups will be able to take the load and you will be able to make the output. So, cellular layout is a new concept, where in which we are grouping machines based upon the part to be produced, producing one or a limited number of parts in a part family.

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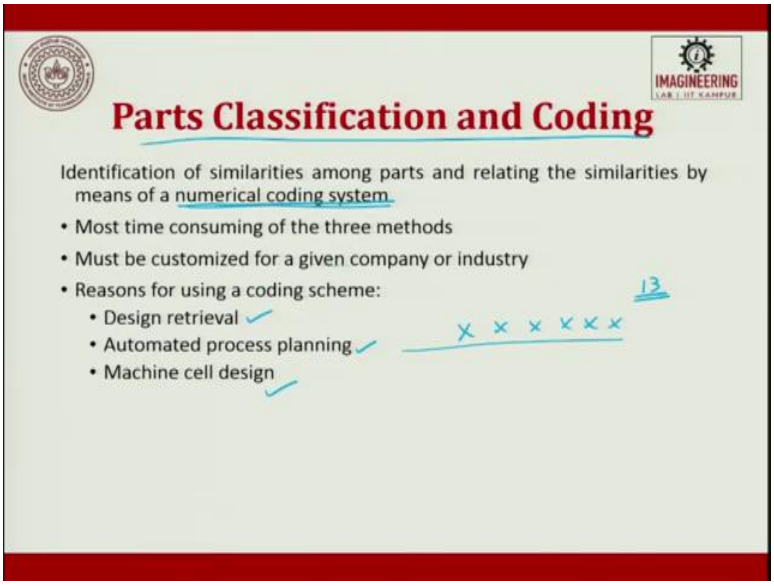

So, the next one is part classification and coding. Classification and coding is very important. Identification of similarity among parts and relating the similarity by means of numerical coding system is very important. For example, when a student joins a college, he is been given a roll

number, as far as the college is concerned the college does not have any value towards the name of the student, till he graduates the system identifies him only by the roll number.

So, now in a roll number, you can have 6 digits, you can have 10 digits, like your bank passbook number, initially we had only 5 digits, 6 digits, today it has increased to 13 digits. So, what is that? It is nothing but converting an individual's account into a unique number. So, which is been given by the numerical coding system, that is what it is. Why? Because as and when the new entry comes into the bank, based upon the coding system, what he has established, he will try to add the member into the banking.

In the similar way what we do is, we try to classify and code every part which comes into the factory for manufacturing or assembly. If you try to take a car, there are minimum 10,000 parts. So, having a record of ten thousand parts by name is going to be tricky. So, what we do is we convert all the names into numbers. So, that numbering is called as numerical system, so that is given by a coding system that is called as numerical coding system. Most time consuming of the three methods is giving the number code.

Must be customized for a given company or industry, it cannot be generic. For example, college to college, the roll number, designation will be different, some colleges have 10 digit number, some colleges have 4 digits, some colleges have 13 digits. Earlier banks also used to have 4 digit number, 3 digit number, I used to remember my father had a bank account number of only 2 digits. But that was an era where we did not have an online transaction to happen.

So, now it is all become online, so now all the banks have to follow a unified system. So, they have 13 digits. So, the most important thing is to identify a coding system, and follow that coding system. First time if you have implemented, then it becomes easy for a new comer to take over. But what are you supposed to do?

You are supposed to customize every coding system, for that particular bank or for that particular industry. So, must be customized for a given company or an industry. The reason for using a coding scheme is design retrieval becomes easy, automating the process plan becomes easy, and machine cell design can also be done easily provided we have a part classification and coding system in place.

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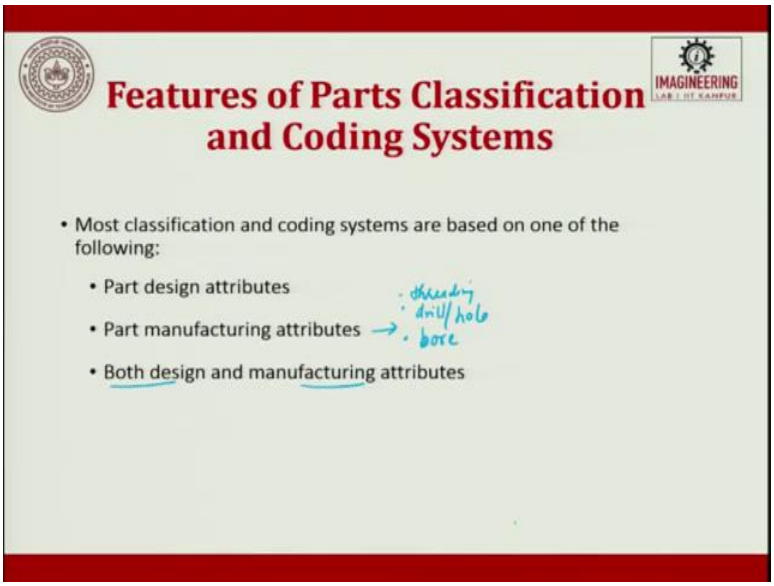

The features of a part classification and a coding system are most classification and coding system are based on the following attributes: One is part design attribute, the other one is part manufacturing attribute, or it can be a mix of these two, both design and manufacturing attributes. What is manufacturing attributes? Manufacturing attributes are nothing but threading, drill, hole, then bore. So, these are all manufacturing attributes, design attributes can be tapered shape, or hemisphere to be made and all those things.

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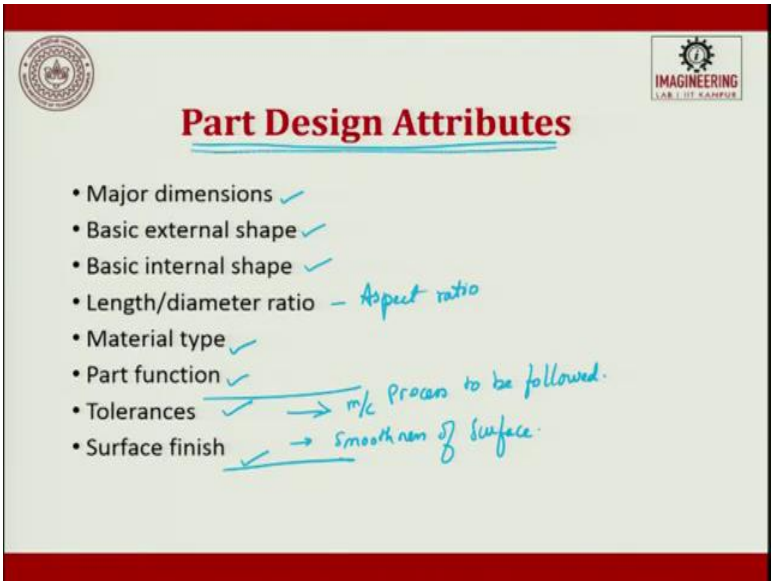

So, what are all the part design attributes? Major dimension, basic external shape, basic internal shape, this is what is called as aspect ratio, then material type, part function, tolerance and surface finish, these 2 terminologies are different, please clearly understand, this talks about the smoothness of the surface. And this talks about the machining process to be followed, process to be followed. Tolerance and surface finish these are the part design attributes.

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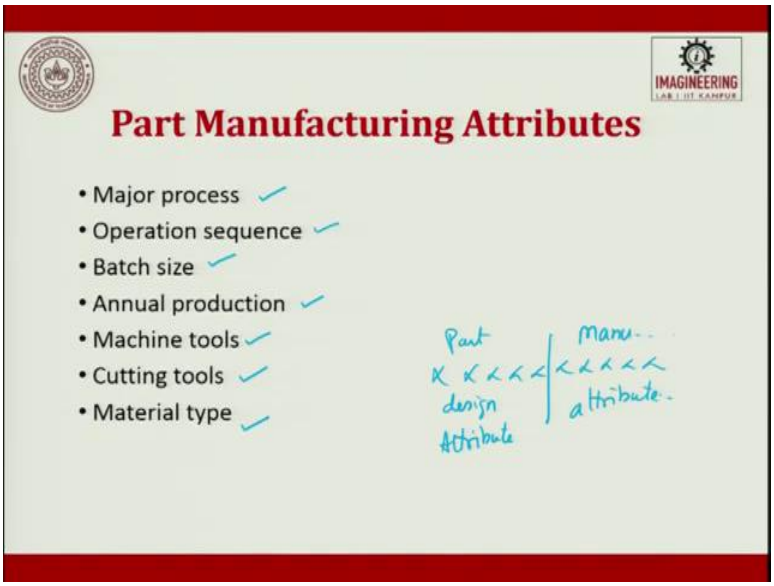

If you want to look at manufacturing attributes, they are major process, operation sequence, batch size, annual production, machine tool, cutting tool, and material type, you see material type is common for both. But this is how a part is classified looking into the manufacturing attributes. First we saw about the part design attribute. Now, we saw about the manufacturing attribute.

You can have a combination of these two and that leads to hybrid system where in which you can have some 10 digits, where 10 digits you will have half of them follow part design, and half of them follow manufacturing attribute, part design attribute and manufacturing attribute. So, this is what is the third classification.

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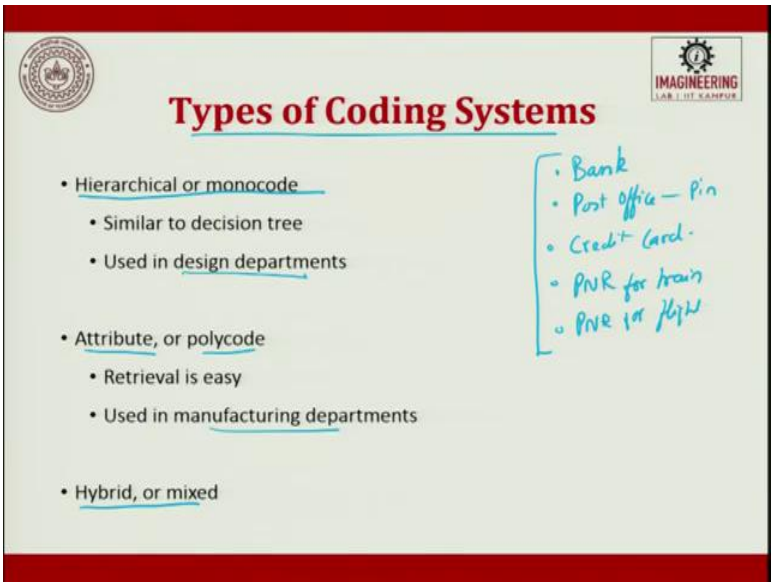

So, based upon that we have 3 different coding systems which are followed, I gave you an example of a bank, they follow a coding system, you look at post office, post office where they have the pin code is a code, then you will have a credit card, where again they have a coding system. How many digits whether to have alphanumeric, you try to take the PNR for the train. So, they will have so many digits, which are fixed, you take the PNR for flight, it will be there.

So, all these things are examples of coding system and they will all be unified such that it can be accepted by any system. So, when the same way, when we take the analogy in manufacturing, we try to talk about 3 different coding system. One is called as hierarchical coding system, or monocode system. The next one is called as attribute, or a polycode system and the last one is a mixture of these two which is hybrid or mixed coding system.

So, in hierarchical or monocode system, we try to follow a decision tree. So, hierarchical or monocode system follows similar to decision tree what we use. Then used in design department, this is monocode. Attribute or polycode, retrieval is very easy, used in manufacturing department. So, hierarchical common in design, attribute common in manufacturing, and a mixed is a combination of these two. These are the different coding system, which are followed in real time.

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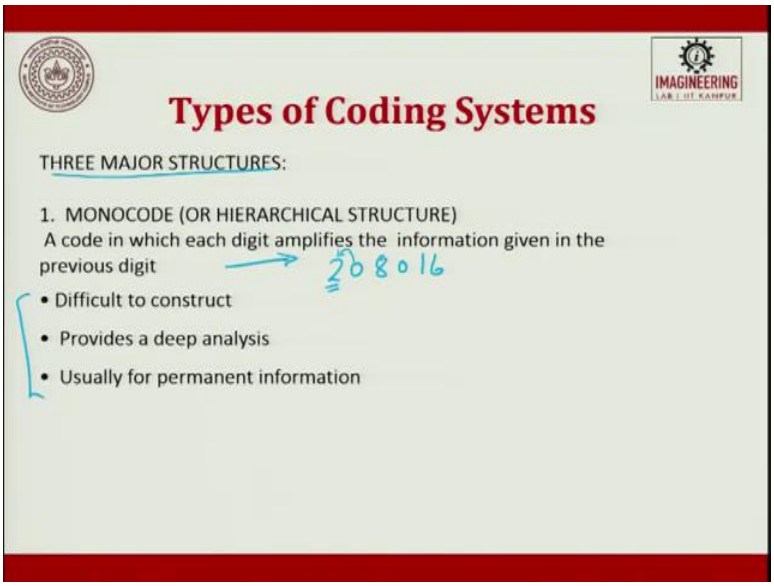

So, there are three major structures, in monocode. A monocode, a code in which each digit amplifies the information given in the previous digit. So, here, if you take an example of 208016 which is the pin code of Kanpur. So, each digit will try to add information to the digit, which is following that, or I should say this digit gets more information from the previous digits, a code in which each digit amplifies the information given in the previous digit.

It is difficult to construct, because in you have 13 digit, it is very difficult to do. It provides a deeper analysis usually for permanent information, that is why I said for a post office, or a bank we can do. So, difficulty to construct monocode is there, provides you have to have a deeper analysis of the complete part and then it gives you a permanent information.

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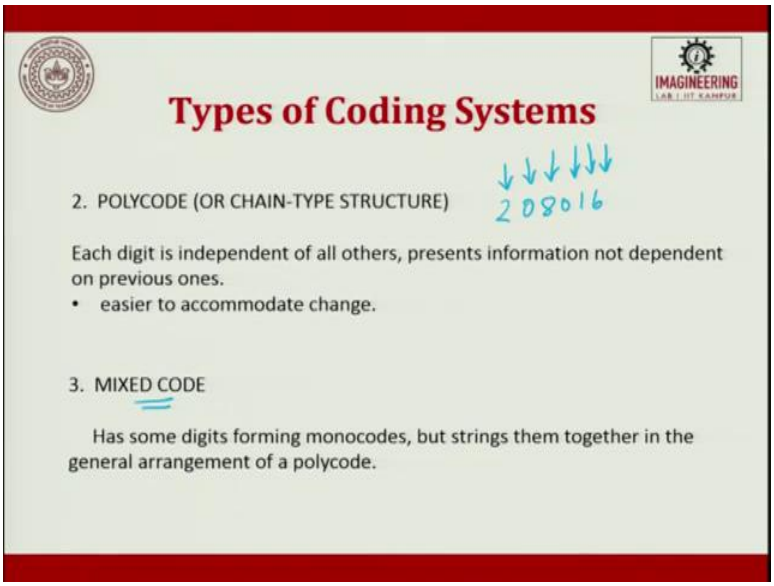

When we talk about polycode, or a chain type structure, each digit is independent of all others, presents information not dependent on the previous. For example, the same pin code 208016, individual digits has information, which has no relevance to the previous digit. But in monocode, each digit will try to get information from the previous digit, or amplification of information is done from the previous digit, for the current digit.

A mixed mode has some digits formed in polycode, and but strings them together in the general arrangement of a monocode and a polycode. Mixed code has some digit forming monocode, but strings them together in the general arrangement of a polycode, that is a mixed code. So, we saw 3 monocode, polycode, and mixed code.

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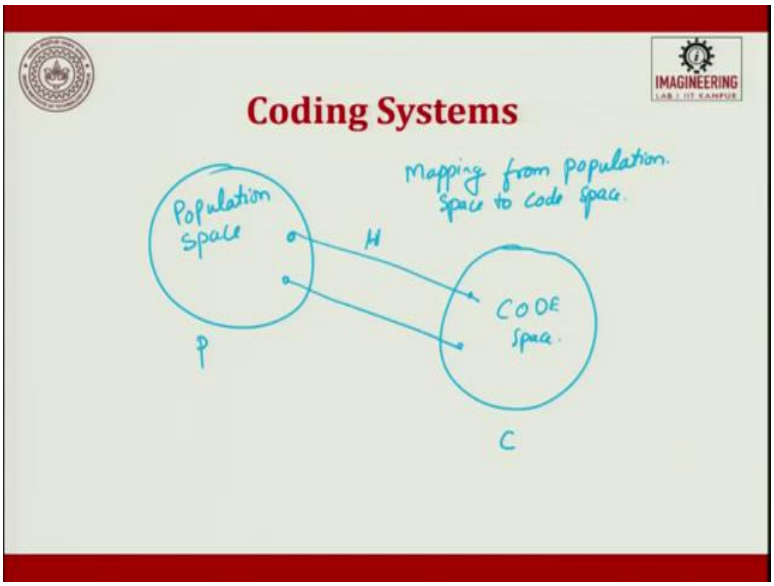

So, let us try to understand the coding system how does it happen? You will have a population space, which is P, and then you will have a code space. So, this is H, and this is code space and you will have mapping everything into the code space. So, mapping from population space to code space. So, mapping this what the coding system does, mapping everything into a coded space. So, every part which comes into the factory can be given a number.

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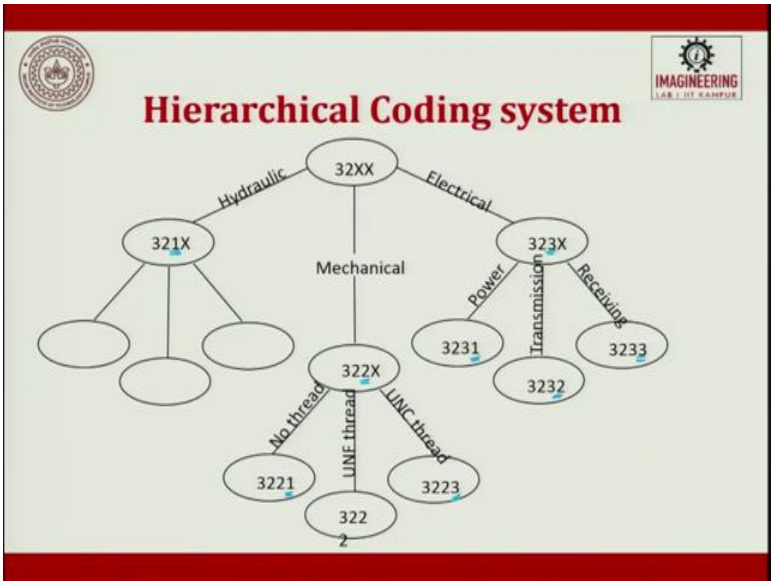

So, the hierarchical coding system, example you can see 32 X X is there. So, hydraulics is 321 X and if it is electrical it is 323 X. So, again here you will have 3 classifications, 3231 is power, 3232 is transmission, 3233 is receiving, and then we talk about mechanical again, 322. So, if you see that 1 is hydraulic, 2 is mechanical, 3 is electrical.

Then the next X, which is again 1, 2 and 3 is the power, transmission, and receiving, when you try to talk about 322 mechanical system X, 1 stands for no thread, 3222 stands for unified thread, and UNC thread is 333. So, you can see here hierarchical coding system is followed. So, every digit tries to take an information from the previous digit.

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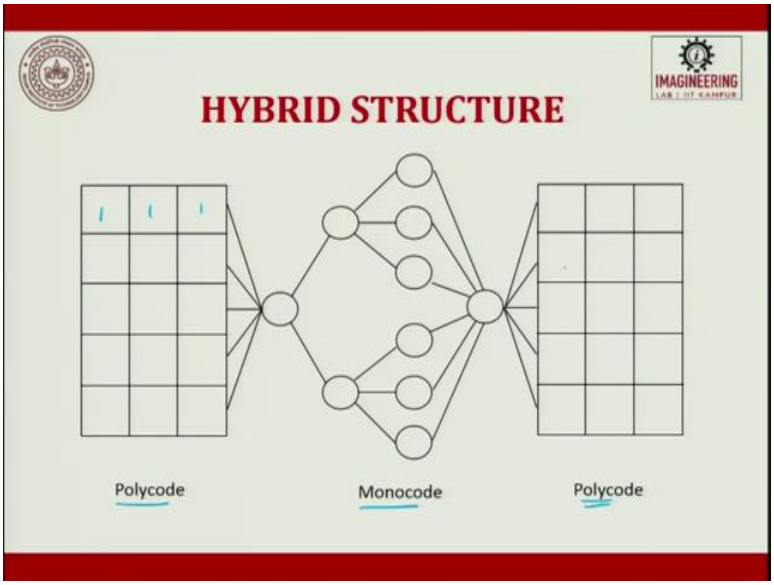

So, in hybrid, you will have first three, this is just a representation. So, you will have polycode followed in the first 3, then you will have monocode followed in the next 4 digit, and next again you can have polycode, which is followed in the last 3 digit. So, here is a mixture of polycode and monocode, polycode every digit has its own relevance in monocode the amplification is happening of the information.

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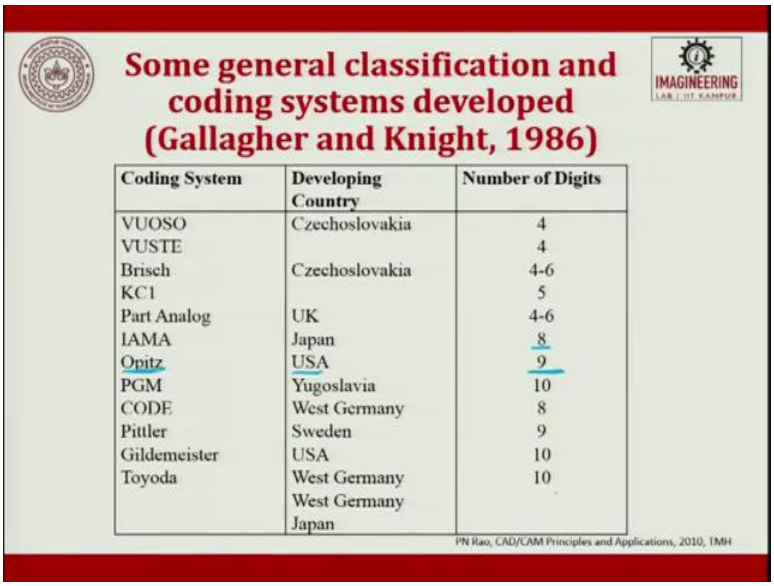

Coding System	Developing Country	Number of Digits
VUOSO	Czechoslovakia	4
VUSTE		4
Brisch	Czechoslovakia	4-6
KC1		5
Part Analog	UK	4-6
IAMA	Japan	8
Opitz	USA	9
PGM	Yugoslavia	10
CODE	West Germany	8
Pittler	Sweden	9
Gildemeister	USA	10
Toyoda	West Germany	10
	West Germany	
	Japan	

So, generally there are several coding systems, which are available. So, here are some of the coding systems, which are very well talked about. And the most common thing, which is generally recommended or most exhaustively used in factories are Opitz code, which was developed by US people and it has 9 digits. We also have so many other quotes, for example IAMA Japanese they have 8 code systems have been developed. And Gildemeister is developed by again US, Toyoda in West Germany they have also develop some codes.

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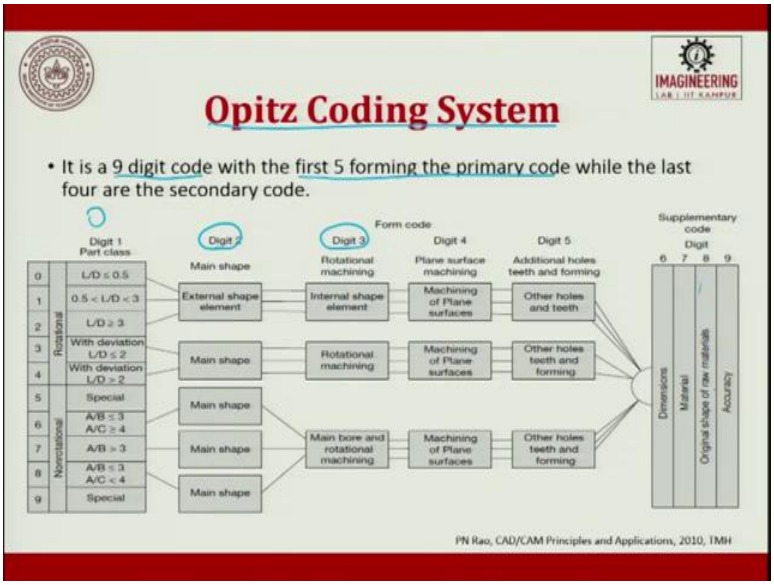

So, when you look at Opitz, which is a very commonly used, it has 9 codes, where in which the first 5 forming the primary code, while the last four are the secondary codes. The first out of the 9, the first 5 digits you see here, they form primary codes. So, the first digit starts with respect to aspect ratio. So, here he will talk about up to 4 is rotational 5 to 9 is non-rotational in the first digit. Next where the features are external or main shape that is a second digit it is there.

The third in rotation internal elements what are there in L by D deviation again in rotating machine what are there and main bore and rotational machine will come in digit 3. So, this is main shape, this is rotational shape, then it talks about planar shape, and the last one it talks about additional like gears or holes, which are there in the system. So, all these things are the first 5 forming primary code and the last four are secondary code which talks about in terms of dimensions, material, then original shape and the last one is accuracy.

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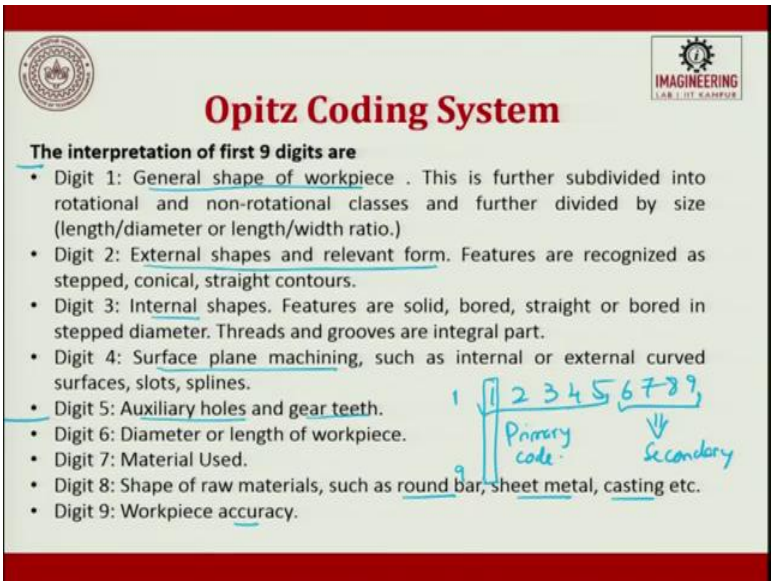

So, digit one stands for general shape of the workpiece, digit two external shape and relevant forms, digit 3 for internal shape, digit 4 for surface plane machining, digit 5 for auxiliary hole and gear, you see that. So, 5 digits are gone, so any part which comes inside a factory from the designer, they look at the feature and just go giving this codes to the part.

So, then the last we have seen diameter, material used, shape of the raw material, such as round sheet, casting, then workpiece accuracy will all be put together. So, you will have a 9 digit number,

where in which these are secondary, and these are primary code, and here from each digit will take a value from 1 to 9. So, you can see how many different options you can have for this coding system. And Opitz is most popularly used and in the similar way, other coding systems are also used.

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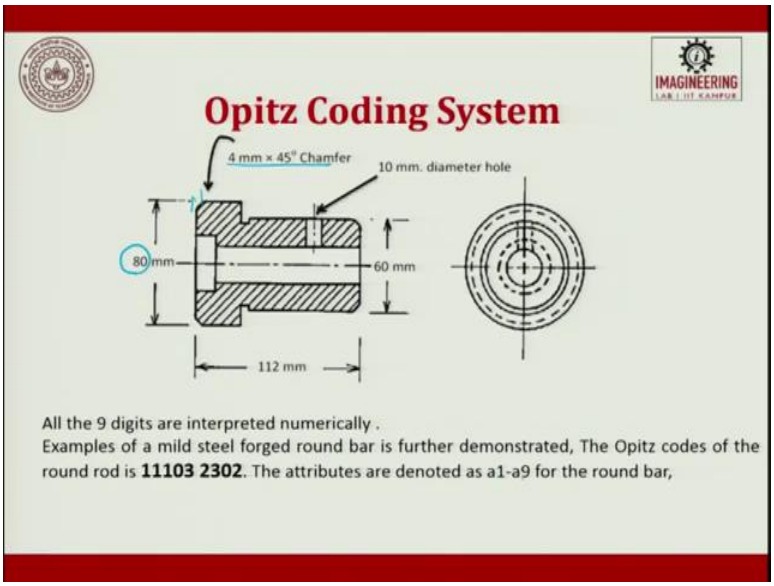

So, when we talk about Opitz coding system for this part, you can see this part, this part is a cylindrical part, where in which it is step turn, you have a groove which is made and then there is a hole which is drilled maybe this whole is for feeding oil or it can be used for putting a double pin for locking this with respect to a shaft.

So, there is a small rescission given, so maybe through this rescission, there might be some other part which is inserted. So, the dimensions are given, 80 diameter of the larger diameter and 60 for a smaller diameter a hole has to be done the total length 112. So, generally when the blank falls inside, the blank will have maybe 115 in length, the total diameter of the bar stock or of will be 80 millimeter from there we will do step turning.

Then the groove is made and the from the assembly point of you there is a chamfer also made for 4 millimeter and then you have an angle of 45 degrees. So, and finally all the shaft is done, so they do an internal drilling of this part and then they turn the part and then they do this counter boring or countersinking they do it. And then they also try to do the hole, which is there in a separate

drilling machine. So, all the 9 digits are interpreted numerically, example of mild steel forged round bar is further demonstrated in using Opitz code 11103 2302. The attributes are denoted as a1 to a9 for the round bar.

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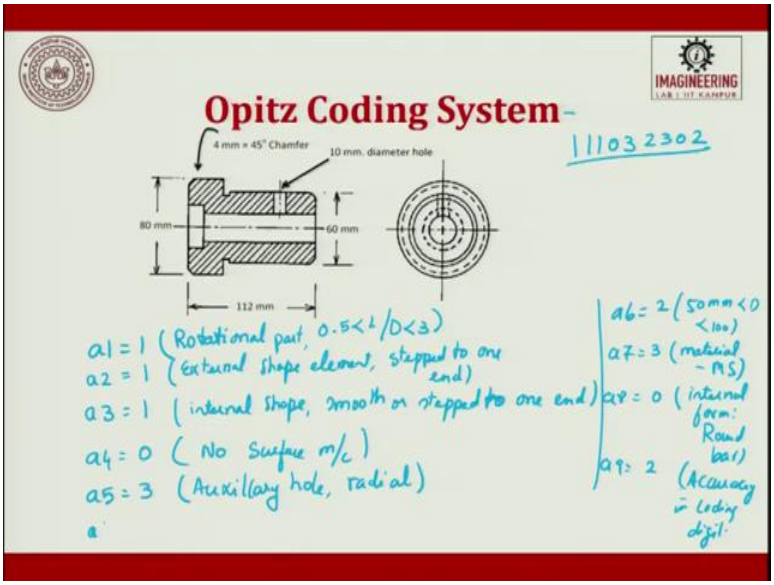

So, let us start doing it, so a 1 is equal to 1, so here the rotational part, rotational part. So, where the dimension 0.5 L to D greater than 3, so it is a 1, so a 2. So, you know it is already been read what is the code? It is 11103 2302, a 2 is 1 where in which it tries to talk about the external shape element, where stepped to one end. So, it is second digit, then third digit is again 1, 3, 1 why is that because it has an internal shape where there is a hole to be drilled, which is smooth or stepped to one end, a 4 is 0, because no surface machining that means to say milling.

So, a 5 is does it have a distingue, so 5 digit, if 5 is 3 where in which it talks about auxiliary hole, radial. So, a 6 so I will write a 6 here, so a 6 is nothing but 2 which talks about 50 millimeter diameter D. Then a 7 is equal to 3 which is nothing but material is mild steel, material MS, then a 8 is 0 which is nothing but internal form in the round bar. Then a 9 will be equal to 2 where accuracy, accuracy in coding digit.

So, if you look at it I have just gone back taken this as an example and I have tried to give a number. So, based on this number we are trying to see how are the parts classified. Now, it is very clear for you just by looking at the part I will try to give the number. Why is this number very

important? Because this number can be now map to the process plan and every time when a component comes all you have to do is pull this part number. So, you can get all the details which will be given in the routing sheet.

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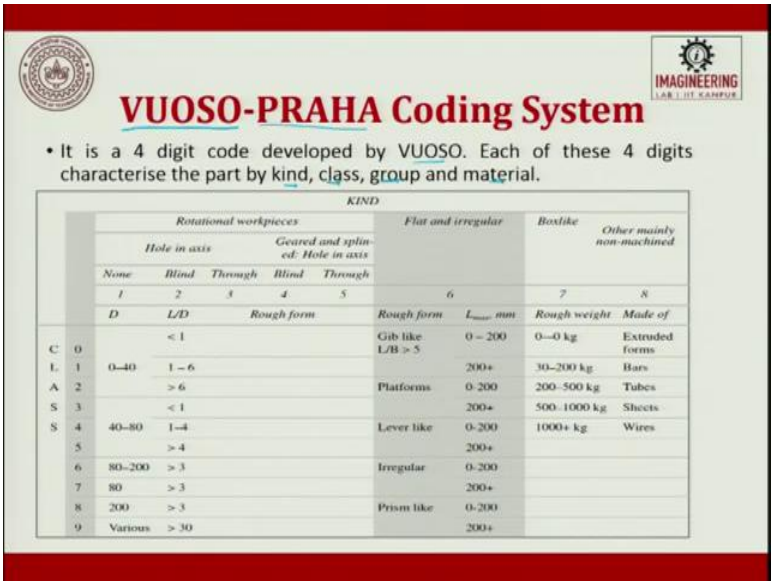

So, this is another coding system we have used, just for your understanding. So, it is VUOSO-PRAHA coding system. So, it has 4 digits code developed by VUOSO, each of the 4 digits characteristics the part of kind, class, group, and material. So, it is another classification system, but Opitz is quite common.

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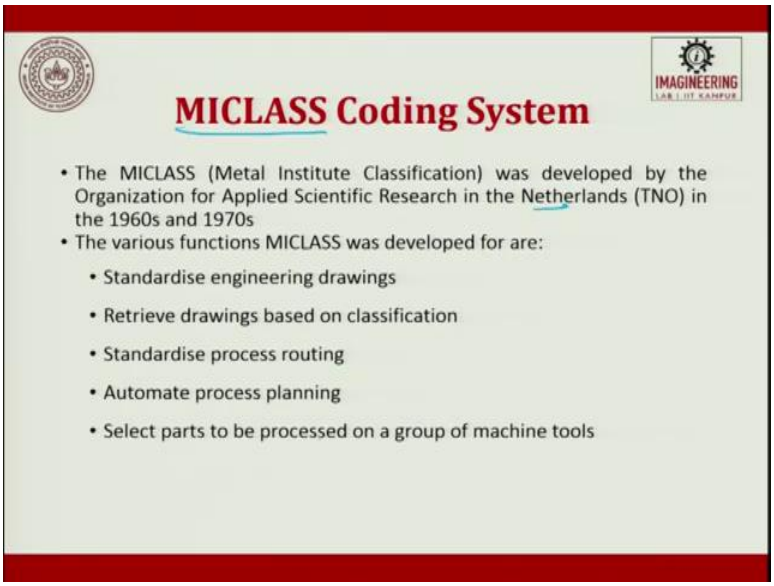

So, you also have MICLASS Coding System, MICLASS coding system is done by Metal Institute Classification, which was done in Netherlands. So, various functions of MICLASS was developed is, standardized engineering drawing, retrieval drawing based on classification, standardized process routing, automated process planning, and select parts to be processed on a group of machine tool.

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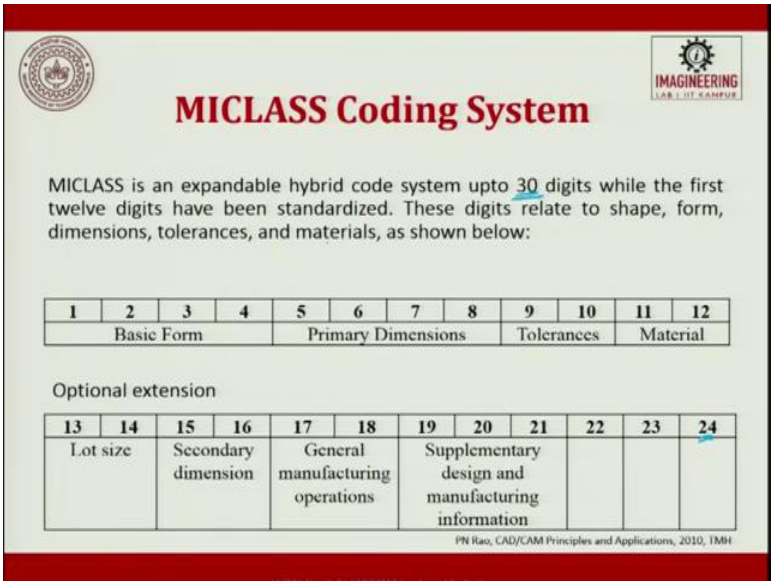

So, this is how it takes, so you look at this one has coding system up to 24 digits. So, these are all optional, you want to use it otherwise the main thing has only 12. So, it has 30 digits, so it should be careful, so but when you do 30 digits you talk deeper into a part, but every time you will have to store a data, you will have to give 30 digit. The first twelve has standardized, these digits related to shape, form, dimension, tolerance, and materials and so on.

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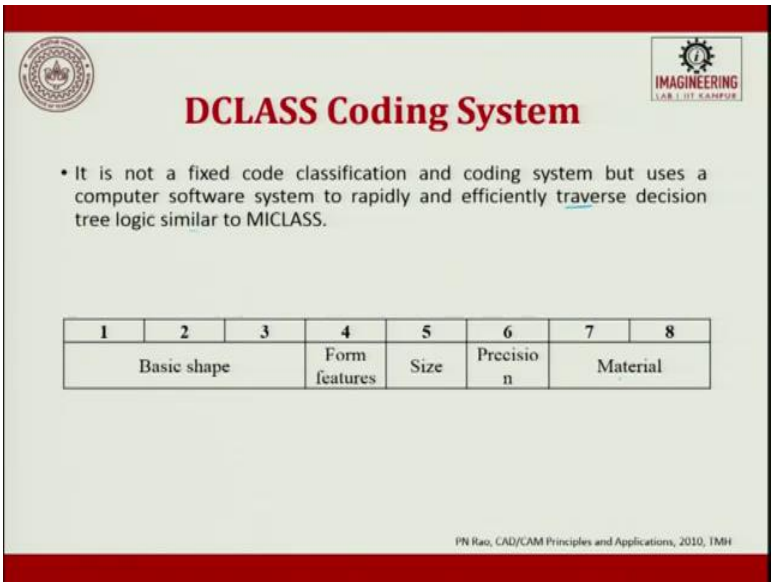

So, DCLASS Coding System, I am just showing you different coding system, DCLASS coding system, there is no fixed code classification and coding system but uses a computer software system to rapidly and efficiently traverse decision tree logic similar to MICLASS. So, we have basic shape, forms, size, precision, and materials. So, it is 8 digits you have.

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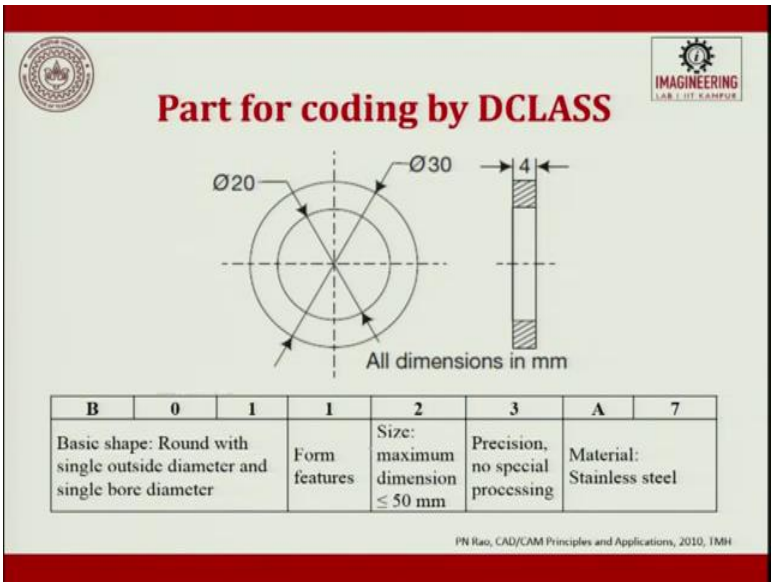

So, part coding by DCLASS, you can say B round, then you can have 0 outer diameter, bore, then you can have form, size, precision, and materials, stainless steel is used.

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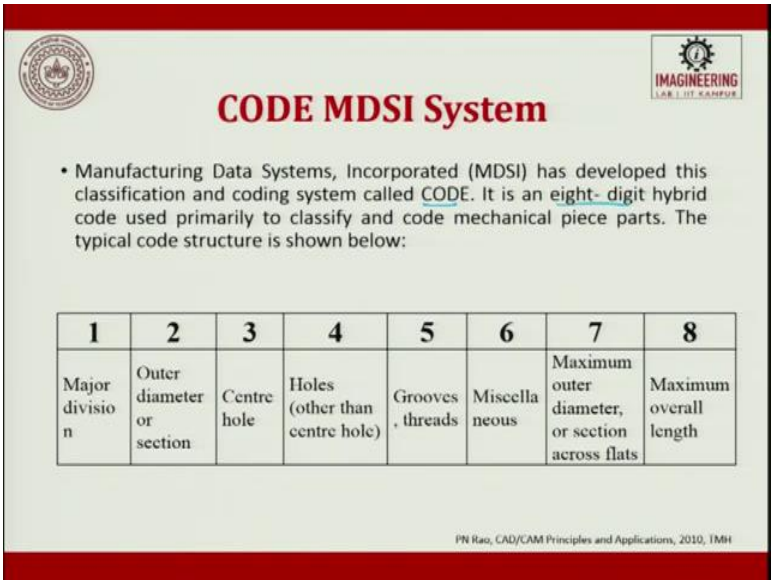

So, MDSI is another system, so MDSI is nothing but manufacturing data system, developed by classification and coding by called as CODE, which has eight digits hybrid coding using primary classification and secondary classification.

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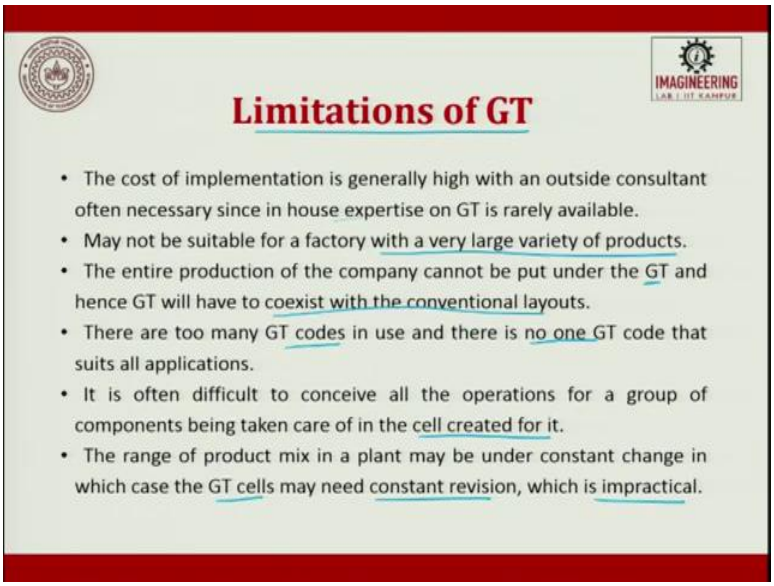

Now, coming to the last, what are all the limitations? Is this ultimate what you get out of group technology? No. So, there is a limitation in it, the cost of implementation is generally high with an outside consultant for necessary since in house expert on GT is rarely available. So, implementing GT is a costly episode, may not be suitable for factory where a large variety of products are there.

For process industry, and for a general purpose industry, this is not recommended. The entire production of the company cannot be put under GT and hence GT has to coexist with the conventional layout, every time you cannot go to a grouping, you will have to follow different loads. There are too many GT codes in use. So, there is no one GT code which is used by everybody, so from company to company, the part number has to change.

So, no point in implementing group technology. It is often difficult to conceive all the operations for a grouping of a component being taken care in of in the cell creation for it. The range of product mix in a plant may be under constant change in which case the GT cells may need constant revision, which is impractical. So, every time it has to change but if the number changes, it becomes very difficult for them to implemented.

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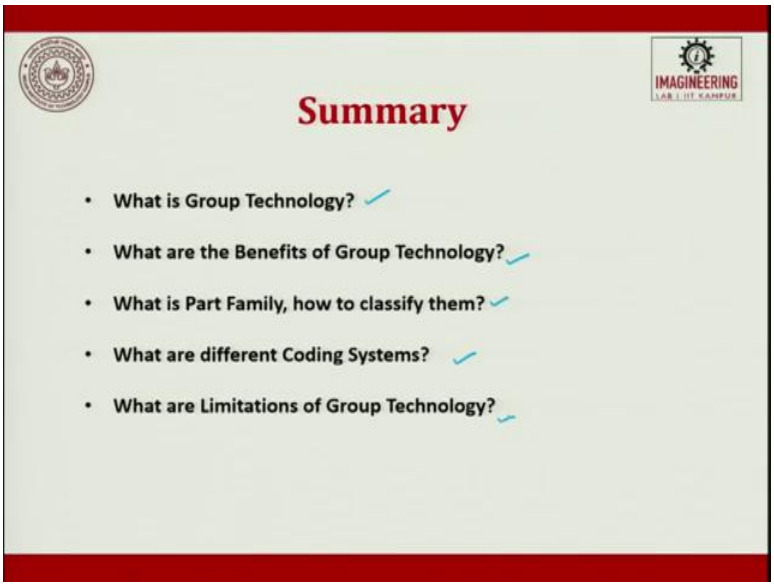

So, to summarize, we have seen what is GT? What are all the benefits of GT? What is part family, how to classify them? Then what are the different coding systems? And later we saw what are the limitations? So, before we conclude, I would like to add a small assignment for you. So, that you can start looking into it.

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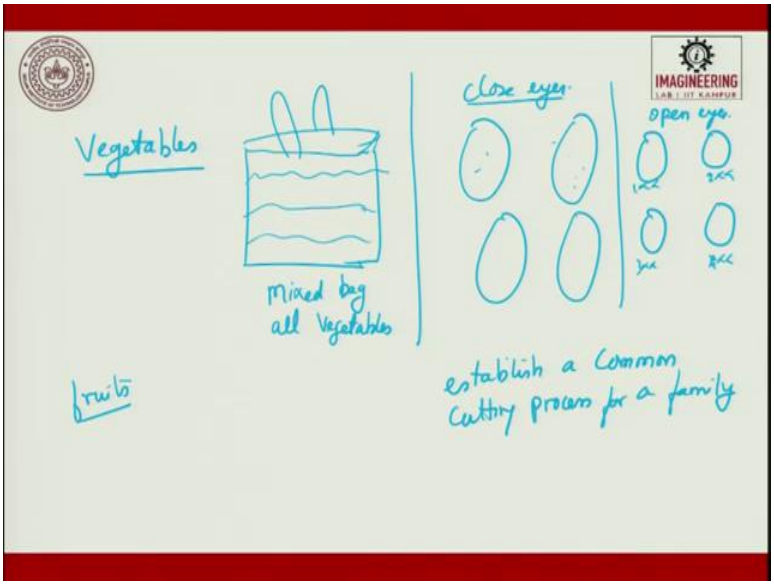

So, this assignment need not to be submitted, let us try to take vegetables, which you buy in market, you try to take a bag, try to take a bag and then dump all with vegetables, different, different,

different, different, different, types of vegetables right. And now this is a mixed bag, mixed bag, all with vegetables.

Now, you close your eyes and now just by touch feel and smell feel, try to form different types of grouping that means to say vegetables of similar size, similar shape, and aspect ratio. So, you should form groups, close your eyes just by touch and smell you can follow this. And after doing it you open your eyes, open your eyes and you will see lot of mistakes.

Now, correct those mistakes and then establish a common cutting process for a family. So, now this is what will happen in group technology also, you will try to group them and once you group them, you give a number and after grouping them you will try to find out some small mistake. So, then you will corrected. So now what do you do is? You try to take a fresh set of vegetables or something or now you have done for vegetables.

Now, you take fruits, apple, orange, all those things and try to classify them depending upon the family what you have already established with the vegetable. Now, what have you done? First vegetable you have grouped. Now, open your eyes and then put it into the classification, whatever you have made. Now it will be so interesting to see you will see and onion you will see and orange.

Now, it comes to a point can we have a common cutting process for this family, where there are fruits and vegetables. Now, this is what happens in a coding system and we did this coding depending upon the size and shape. Now, you have coded 6, 7 groups. So, give numbers to each group that is what you are trying to do.

So, if you do this exercise, you will start appreciating when a new part comes inside an industry, how are they trying to put it in a family and how are they giving number to the product, with this I would like to finish my lecture on group technology, please try this exercise. So, that you will appreciate the difficulty in the group technology establishment. Thank you.