Manufacturing Guidelines for Product Design

Prof. Inderdeep Singh
Department of Mechanical and Industrial Engineering
Indian Institute of Technology-Roorkee

Lecture-02
Introduction of Manufacturing Processes

Namaskar friends, welcome to the second session of our course on manufacturing guidelines for product design. As we have seen in the first session that was the introductory sessions for this course, that what we are going to cover in this course. Another thing that came to my mind after the introductory session was that how this course fits in into the academic domain or the learning domain of a mechanical engineer or of a production engineer or of a design engineer or of a manager.

So this course basically addresses the bridge or tries to create a bridge between a designer and the concept of engineering. So basically if you see around yourself or if you see around you you will see so many products are there. For example normally I take the example this is one pointer comes slide changer, it is the product, it has been made using standard manufacturing processes.

Now those manufacturing processes may be dedicated towards molding of plastics because it is a plastic product. Similarly if it has to be made in metal we need to have understanding of the processes which can used for creating this type of a shape. So mechanical engineer undergoes a curriculum in which he or she is taught is regarding the basic concepts of manufacturing process.

Then they utilise this information or use this information during their service or during their professional career. But many a time whenever a designer is designing a product he has no information regarding how this product will be manufactured. Similarly when a mechanical engineer looks at a design sometimes he feel that this could have been done in a better manner or it could have been designed in a better manner.

So that it is easier to manufacture, so there is a gap between a mechanical engineer's thought process related to the product design as well as the product designer's thought processes related to the manufacturing of the product. So we have tried to design this course in such a

way that we are able to understand that what are the guidelines that have to be kept in mind when we are designing a product. So from mechanical engineers point of view we will boil down the information into standard guidelines which are already available.

And may not be taught in the UG or the PG curriculum and from designers point of view who has little or no knowledge about the manufacturing we will try to frame certain guidelines, we will try to discuss certain guidelines which is followed can help him or her to design the product in a better manner or can take a informed decision that this product can be manufactured in the best possible manner using this particular process.

So that is the bridge or the gap that we want to fill, we want to develop or we want to discuss the guidelines for mechanical engineers, mechanical engineer may be knowing that what is the casting process, how to design the gating system for the casting, but sometimes when the product has to be manufactured that guidelines that this product that must be the change in the cross sectional area allowed if the product is long may be we have to see that the cross sectional area at one section is higher other section it is too low.

In that case what type of problems may come, so there may be certain guidelines established based on the research, based on the experience which can help a mechanical engineer to figure out that if the product has to be made by casting what are the things to be taken care of, normally in our curriculum we see that we are taught regarding the processes, regarding the application, regarding the limitations.

But we usually lack the design guidelines that are established for the various processes very seldom our students know that if casting has to be made a product has to be made by casting process, what are the various design guidelines to be kept in mind for the design point of view or from the product design point of view. So that is the basic thing that we need to understand here.

Another thing I would like to mention is here is that we are not going to study the manufacturing processes in this course and if you refer to MOOCs the massive open online courses which are available, there are number of good courses where lectures have be delivered by the experts of manufacturing engineering or processes who have recording the lectures and have been run successfully.

This courses have been run successfully, our target is to understand the guidelines which can be helpful for a product designer. So if you are if you want to design a product what are the various guidelines that have to be kept in mind. So we can say that this courses slightly on the applied sight that we will be just taking casting as a process may be 15 to 20 minutes of discussion on the casting process.

But the more focus will be on the guidelines that once you are designing a product what things related to casting you must keep in mind. So that you are able to produce a good product, so casting I have taken an example because it is a well-known process in manufacturing engineering. We will discuss regarding the manufacturing guidelines for the plastic products also.

Like one example I have already taken or we will take different examples with the mouse or the cabinet of a commuter system. So we have different types of products that we use all around us, we may be using a simple key chain or we may be using a pen, we used different types of product a handle of the brush, the bristle that are fixed on the handle of the brush for brushing our teeth.

So right from the waking up in the morning till we go to bed we use different types of products which are manufactured using different types of processes it may not be possible for us within this 20 hours of discussion to cover each and every manufacturing process that is used for processing of a fabrication of products. But we will try to limit our discussion to the most important and most widely used processes that are used for manufacturing of products.

So we start the discussion today by classifying the manufacturing process or by introducing the concept of manufacturing process, the title for today's introduction of manufacturing processes. So let us see the importance of the manufacturing processes. Now these days each and every customer looks for quality. So quality is the key words these days.

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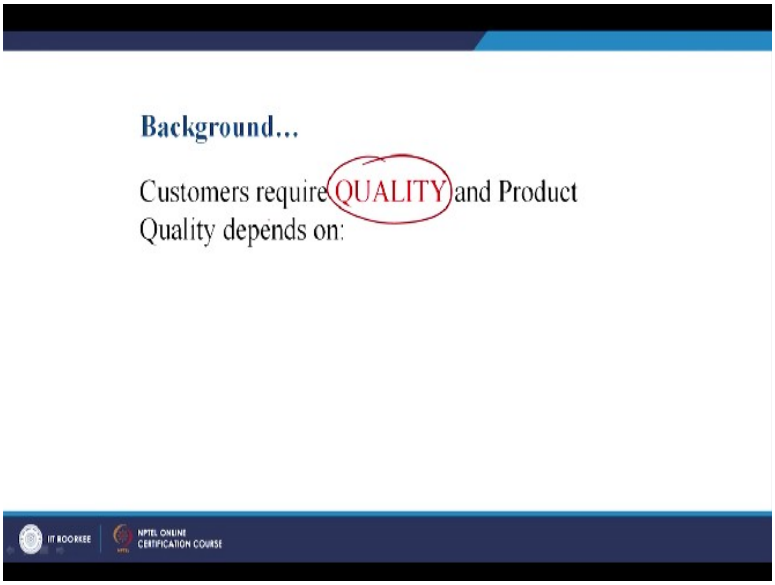

And how quality is defined that we can see, we can see that what are the important characteristics that have to be controlled in order to deliver the quality for our customers. So the customers required quality and the product quality depends upon I can give you just 10 seconds to decide that what can be these parameters number of answers will come, all of you will have different answer, some of the answers can be if the product performs it intended function it is of good quality.

Then how to ensure that the product performs its intended function, for example I have used this pen, I have used it to mark quality here, now suppose I start using it, it is not working properly or I will say what is this is a having a very poor quality I was trying to use it and I was not able to draw circle around quality, so poor quality, so we say quality is a certain when that intended function is achieved by the product.

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But how to ensure that we can ensure that using 3 important we can say aspects or the characteristics, so the first one that is very very is important is the product design. So product design is very very important and if you remember some of you may be familiar with the lectures that we have covered till today. We already have run successfully 2 times or 10 hour course on product design and development.

So we will not go into the importance of product design but certainly it is an important parameter an important characteristic an important aspect and important criteria which defines the qualities. So the design of the product is good the qualities will definitely will be better, so we have to ensure that the product design must be excellent. Now how we can ensure that the product design is excellent.

We have to have this understanding of the guidelines through which we are going to convert our idea into the product. So the first and foremost important thing is the product design. So design has to be successful and how it will be successful if we have all the information related to the product design process. In the end when we do a prototyping of a product beyond that the product goes for commercialization and actual manufacturing of fabrication.

During that time we have to keep in mind that how the product is going to be manufactured. So during that design stage only our focus must be that how the product is going to be manufactured. So the first important part is the design, the second is the materials that are going to be used, so that as we I have already told this is the product made out of plastic, then there can be products made out of metals, products made out of wood.

And each and every material will have dedicated specific manufacturing processes those will be used for processing the materials. So therefore from materials point of view also we must have the understanding of the manufacturing guidelines, why because the manufacturing guidelines may vary for wood, manufacturing guidelines may vary for metals, manufacturing guidelines may vary for plastics, manufacturing guidelines may vary for composites, manufacturing guidelines may vary for ceramics.

So you can see that if the material is changing the manufacturing guidelines also change, so we must have idea about the guidelines so that we are able to design the product in such a way that we use a specific material for making the product and finally we must have information about the processing technology and here our off shoot or the summary of this is what is our target in this course.

We need to understand the summary of the processing technology, for example if the product we have already designed the product we have selected the material which is the metallic part or it is the product has to be made by using a metal as the material. .Now we have to do the machining of that part or the product. Now what are the guidelines for machining, there may be specific guideline that may be required when we are designing something.

One example we can take suppose this is a part we have to have a hole here so when the hole is required at the edge there must be some guideline that how much portion of the hole has to be inside the main body of the part. This can be some guidelines, so if that guidelines we know we will take that guideline into the design process, when we are designing our product we will keep this guideline in mind that what portion of the hole must be there in the body of the part.

And that guideline will help us to avoid any poor design. This is one example I have taken there are number of such examples which can be taken into account and which will be discussed with the help of examples, diagrams, videos whatever possible in the lectures we will try to cover. So that once you are complete with the course you are able to focus on your design by keeping these guidelines in into your thought process or keeping this guidelines as a reference tool while you are designing a product.

Once you decide the product has to be made in a plastic material and it has to be made by injection moulding process you must follow the product design guidelines which have been established for the injection moulding process. So that you produce a good quality product which is acceptable to the customers. So that is the summary of what we are going to cover in the next be probably 19 hours of our discussion.

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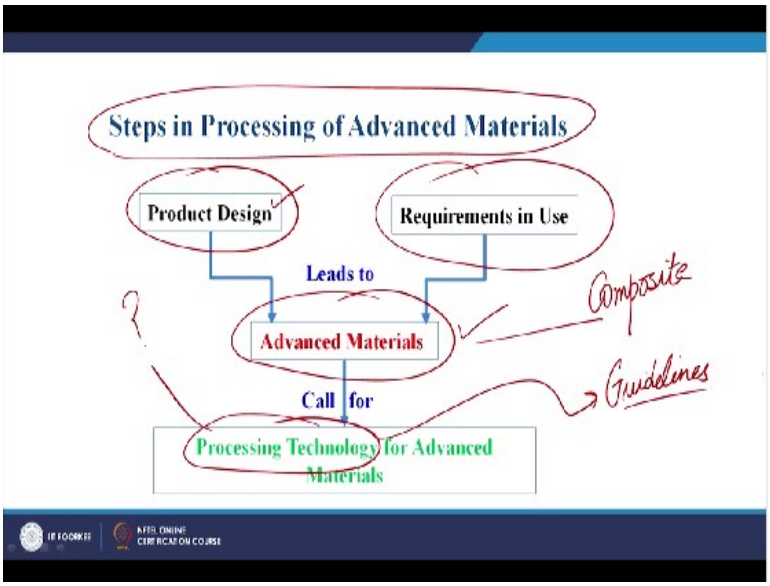

Now what are the steps that have to be followed for advanced material. Now suppose we decide on developing our product in a new material in advanced material. So first thing that has to be taken tinto account is the product design, you can see that product design is very very very very important aspect in today scenario when there is lot of focus on innovation there is lot of focus on entrepreneurship, there is lot of focus on starting business.

So there the product design becomes very very important, so if you have a good product design we can very easily run a successful business and then we have to see that when we are talking of advances materials or new materials we have to adjust our product design accordingly. **See** Similarly we have to understand what are the requirements in use, that when we are going to use the product how or what type of environment.

What type of conditions it is going to encounter and that leads to the development of advanced materials. So the once we know that advance materials have been develop we must have the information about the processing technology and here also our course is going to address that once for advanced materials or new type of material what are the guidelines. So

we have these are the materials maybe 1 category of these materials can be composite materials.

And what are the processing guidelines for these materials because whatever are the traditional materials that are being used more or less there are standard guidelines which we are going to cover, we are not going to exclude those guidelines, we are going to cover those guidelines also for standard processes, but with new and new developments taking place, new and new requirements coming up for product designs or for different types of products we need to develop new materials.

And for new materials we need to have new processing techniques tools and for these techniques there have to be standard guidelines which have to be established so that our product is made in a successful manner or made word I can code it is processed, it is fabricated, it is produced, it is manufactured in the most economical manner to the best of quality. So that is our target.

That once new materials are also coming into picture we must be able to establish the manufacturing guidelines from the product design perspective and that we are going to see in our subsequent sessions.

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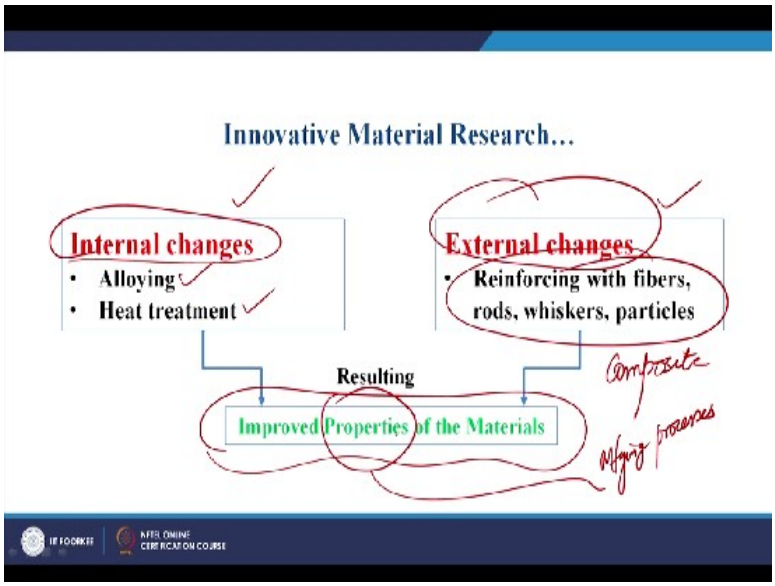

Now new materials how they can be developed, let us see we can do some internal changes in the materials which can be alloying or heat treatment or there can be some external changes which can be this total will lead to the composite materials which I have already written there

in the previous slide also. So reinforcing with fibres rod so we need not get too much worried about what is this word composite.

And what are the different types of composites or how it is related to the course, the course basically tries to establish the manufacturing guidelines which can be helpful for the product designer when they are designing new and new products. Now these products can have used different types of materials. Now materials can be metals, they can be ceramics, they can be wood, it can be a plastic, it can be a composite, it can be a shape memory alloy.

It can be a nanomaterial, so for a specific type of product specific type of materials will be used and for these there will be certain manufacturing processes those will be used for converting them into the final product as per the product design. So our focus is to understand those manufacturing guidelines. But this slide is just giving an indication that how the new materials can be developed.

So new materials can be develop by doing the internal changes or the external changes and once we try to develop a new material it will lead to improve the properties of the material, how it is related to our course because when the properties of the material will change the manufacturing processes also need to be controlled, also need to be designed in such a way that we are able to produce these new materials as per our product design.

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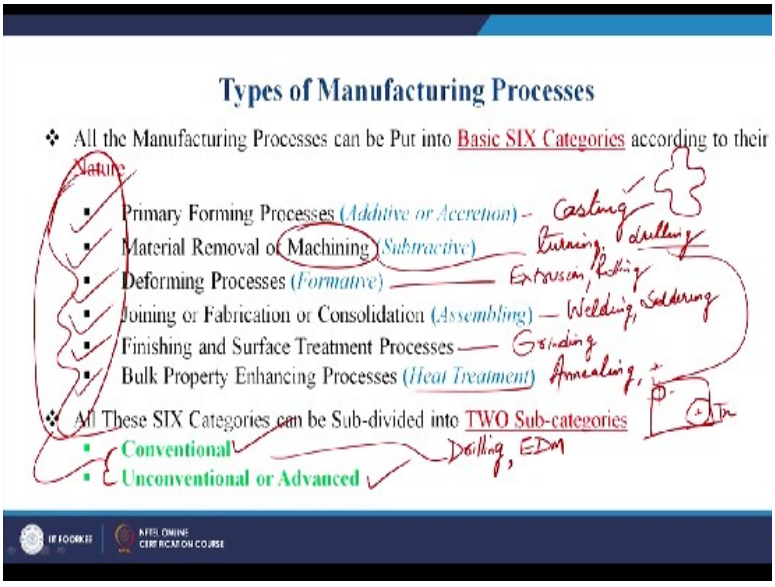

Now let us see the main topic for today that what are the types of manufacturing processes. Now all the manufacturing processes can be put into 6 basic categories. So we are not going

to get intricacies of each and every process that how this process is done, but we will see that what are the guidelines for this process. So we will be focusing on the guidelines majorly instead of focusing on the process.

Process if you are really interested to get know about the process that how the process is done then you must follow other courses which are already revalent which are already being run successfully may be for the last 1 or 2 semesters, our focus is on the guidelines which are established for these processes. Now what are the processes these are the processes on your screen, the primary forming process one of the example here can be the casting process.

Then we can have metal remove already the example is given machining which is the general term, then we can within machining we can talk of turning, we can talk of drilling, so we have primary forming processes, we have material removal processes, we have deformative processes, we can take an example of exclusion here, we can take an example of rolling here, then there are joining or fabrication or consolidation process.

We can take an example of welding or we can take an example of soldering here, then there are finishing and surface treatment processes we can take an example finishing can be one of the most common process is grinding, there can be other super finishing processes also, then bulk property enhancing processes such as the heat treatment. There can be processes like annealing or we can have a tempering process also.

So we can see that the general manufacturing processes can be classified into these basic categories and we will try to understand the guidelines which have been established for some of these processes because all we cannot cover in a short span of 20 hours. So our focus will be on the most commonly used manufacturing processes and how they can be we can say harnessed for making our products.

So that will be out target here, so in primary forming we have seen casting, so what are the guidelines for casting. So for example we can take a product which is something like this, which and which has to be made by casting, what are the guidelines for making this product as per our processes of casting. So we will see what are the guidelines or what important checks or what important requirements must be kept in mind once this type of product is to be manufactured.

That is target that we are going to achieve after undergoing this course, similarly for drilling I have already taken an example in the previous slide that how much portion or how much area of the hole must be within the plate if the hole has to be made at the edge just one example of making holes. So for hole making what must be the difference between the 2 holes, now suppose drilling we can take an example.

Suppose this is the plate we want to make 4 holes, so what must be a centre distance from the edge, this distance x or if you want to make a hole here, again what must be this distance x in order to make a good quality hole which does not serve to impair the performance of the product or which does not hamper the performance of the products. So all these guidelines is our target and these guidelines will become a handy tool for each and every product designer, for each and every mechanical engineer who is involved in the product design process.

If this guidelines are followed religiously the product will be developed to the best of quality and ready design may not be required, but many time it happens that we have designed a product but once it goes into the actual manufacturing it is sent back to the designer with some notes or with some suggestions or with some issues that cannot be addressed in manufacturing.

So that is the basic concept for design for manufacturing or design for assembly. So our focus is more on the technical content because from design for manufacturing also 2 aspects are there, one is the hard core engineering aspect, another one is the industrial engineering aspects, our focus primarily is on the engineering aspect for design for manufacturing. So we will focus more on the guidelines related to the manufacturing processes which are helpful for the designers in the design of the product.

So that iterative thing I was I was talking about that once the design is final with the product design it goes to manufacturing and then it has to come back sometimes because of lack of consistency in the thought process of the designers and people who are actually responsible for manufacturing the product. So that can easily be avoided if the designers keep all these manufacturing guidelines in their mind related to the various processes that are going to be used for fabricating the products.

So 2 or 3 examples I have taken so we may not be going into the intricacies again and again I am emphasizing we are not going to study casting in detail but we are going to study casting details or casting guidelines as applied to product design. Similarly machining guidelines as applied to product design process. So that is the target, so these are the broad we can say classification of the manufacturing processes.

Let us see another slide which will make them further clear, so these are the 6 categories then there can be 2 sub categories also, we can have these processes which can be conventional or sometimes unconventional or advanced. Now how can we differentiate now conventional process is a processes which are used for so many years and which have established themselves as the commercial processes for manufacturing of products or manufacturing of materials.

But unconventional processes are sometimes which are may be in the research state or which are beyond the conventional processes, for example in conventional machining the tool will come in contact with the work piece and will remove the material in most of the processes whereas in unconventional method of removing the material the tool may not coming contact with the work piece.

So the material may be removed by other action sometimes the abrasive action can lead to removal of materials, sometime the direct vaporization of the material melting and vaporization may lead to removal of the material, sometimes it may be removed by only by the application of heat. So but the tool is not coming in contact with the work piece. So that is something which is unconventional.

Conventionally whenever we remove the material we feel that the tool will it will rub against the work piece and remove the material whereas in unconventional approach the tool and work piece are out of control may be not out of control I must say are not in contact with each other. So that is the basic difference between conventional. So all this 6 processes that we have listed here can further be classified as conventional and un conventional.

For example usually it becomes clear in conventional processes or conventional machining we can take a process for hole making as drilling but if we talk about unconventional we can have a process called EDM, which is electric discharge machining. So we can make a hole

using EDM also and we can make a hole using conventional drilling process also. But what is the difference in conventional drilling the tool will be contact with work piece and physically the material will be removed.

Whereas in EDM process the tool will not be in contact with the work piece and only the spark that is generated between the tool and the work piece will remove the material from the work piece and a hole will be created. So that is the basic difference between conventional and un conventional and if you see the list you can easily categorised into a tabular form name of the category that is primary forming, then you can write what are the conventional primary forming processes. Next column can be what are the unconventional processes. So you can have conventional primary forming.

You can have un conventional primary forming processes, so that way you can classify and I think this is the good assignment for all of you in the very beginning of the course that when you are classifying the manufacturing processes, 6 categories already told, then the sub categories you can take an example in different books you will find it in the tabular form, that what are the conventional primary forming processes.

What are the conventional material removal processes, what are the conventional determinative processes as well as what are the unconventional primary forming un conventional machining or un conventional material removal processes as well as unconventional deformative processes. So I can take examples of each one of these but due to the paucity of time and focus area of our course I am not going to get into all those details.

Otherwise may be just to the explain to all of you just one more example if we talk about this deformative processes the conventional can be rolling process it can be extrusion, it can be wire drawing, tube drawing, all these processes will fall under the conventional deformative processes or conventional deforming processes. But if you go to unconventional deforming processes you can take the example of explosive forming.

You can take the example of explosive forming you can take the examples of hydroforming so you have different ways of deforming the metal, in previous case we have taken conventional techniques like rolling, extrusion, wire drawing, tube drawing, standard

processes which are used for changing the shape of the metal. Whereas from the un conventional side we are talking about 2 different examples just now I have taken.

Explosive forming used the detonation and you explode the ways will deform the sheet in the form of the die in which if we are hitting it against so there may be a die, there may be a sheet, and there may be detonation and explosive as soon as the waves will hit the sheet, the sheet will take the form the die after being after the explosion. So we can have un conventional deformative processes also.

So this example I have taken just to have a give you an idea that all these processes that are listed here 6 processes are listed here in primary forming material removal processes, deformative processes, joining processes, finishing processes, bulk property enhancing processes, each one of these process can be both having conventional processes as examples as well as unconventional processes as the examples.

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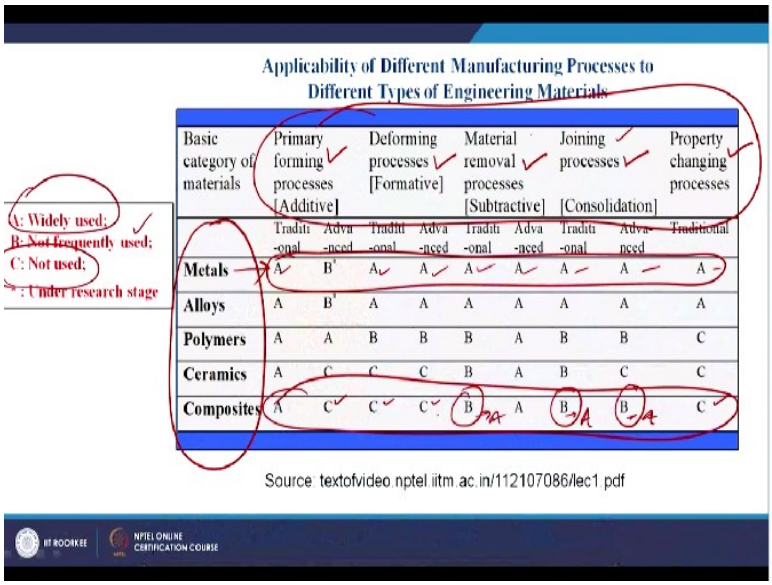

Basic category of materials	Primary forming processes [Additive]		Deforming processes [Formative]		Material removal processes [Subtractive]		Joining processes [Consolidation]		Property changing processes
	Traditional	Advanced	Traditional	Advanced	Traditional	Advanced	Traditional	Advanced	Traditional
Metals	A	B	A	A	A	A	A	A	A
Alloys	A	B	A	A	A	A	A	A	A
Polymers	A	A	B	B	B	A	B	B	C
Ceramics	A	C	C	C	B	A	B	C	C
Composites	A	C	C	C	B	A	B	B	C

Two examples already I have taken first one was related the material removal processes, the second one is related to the deformative processes, 2 examples already taken. Now this is source is given applicability of different manufacturing processes to different types of engineering materials. So this is the list of processes on your screen you can see here, these are the processes which we have already covered primary forming processes, deforming processes, material removal processes, joining and property changing processes.

These are the engineering materials which we are going to cover in our second week of discussion, that what are the various engineering materials and what type of products can be made using these type of materials or what are the manufacturing limitations for this type of material. So we can see that A is widely used, so for metals if you see in this column most of the process are well established.

So we have A in most of the processes, so metals can be easily fabricated or easily process or easily produced or manufactured using any of these processes, it depending upon the specific requirement we will choose, is the 2 parts are to be joined together definitely we will go for a joining processes or if holes have to be made we will go for a machining process or the material removal processes.

So specific requirements will lead to use of specific processes but metals it is established that most of the processes are well known or well researched as well as well commercialized, whereas if you take any other example, let us take the example of composites so here you can see there are number of C so C means not used so you have a C here C, C another C here and B is not frequently used.

So we have a B here, we have a B here and we have a B here, which means that for composites lot of research efforts are required you need to develop new better processes, so that these are also converted into As, that is there also widely used and this Cs can also be converted into A that is these processes are widely used for manufacturing of composite materials also.

So this is quite clear from here that form metals most of the processes are very well established and for other types of materials like composites and ceramics as well as for polymer we need to fine tune or we need to develop an understanding about the manufacturing processes. So that these materials can also find application all around us. So for plastics if you see these days lot of products are being made using the polymers or the plastic.

It means the manufacturing processes are now well developed for manufacturing of polymers or plastics or for processing of polymers or plastics and therefore the importance of this course is further may be substantiated why because when plastics are being used in such a big

way we must know that what are the manufacturing guidelines or the processing guidelines that we must follow when we are designing a product that has to be made in a plastic material.

So that therefore we need to hone our skills to make our skills relevant from the product design point of view by focusing on the manufacturing guidelines, sometimes we may propose a very good design but we do not know that how this product is going to be manufactured, in that case what is going to happen the product designer it may look very good, but it cannot be manufactured.

So if we have idea that x process or y process or z process which is used for processing of plastic can process this this type of shape, can process this type of a design very easily we can choose the process, we will modify our design, we will tweak our design, we will fine tune our design, keeping in mind the guidelines that we know for a specific process and therefore the iterative thing that once we are finalized.

We are not able to manufacture it, we are not even able to prototype it, again we change the design, we make some modifications, again we are not able to prototype it. So then these problems will be there. So these type of problem can easily be overcome if we follow the manufacturing guidelines for the specific process by which the product is going to be converted into a final form or into a fully commercial product.

So these are some of the we can say summary of the manufacturing processes we service the engineering materials that are which type of material which type of process is well developed.

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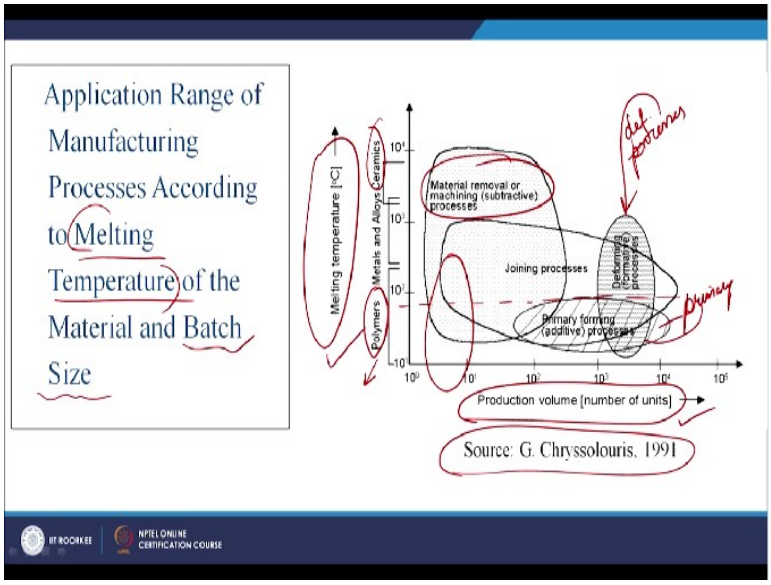

This is another we can say guideline or another criteria which can help us to decide that which process can be used under certain circumstances or under certain specific circumstances. So this is based on 2 important parameters first one is the melting temperature and the another one is the production volume or the number of products that have to be produced which can also be called as the batch size.

So on Y axis we have the melting temperature, on x axis we have the production volume, so when once we have to a select a manufacturing process we must focus on these 2 parameter. So we can see if the melting temperature is very very high, so we cannot use a casting process because in casting we need to melt the metal. So we can see here this is our primary forming processes we can see it is written here primary forming.

So casting falls here, so it can only be used upto melting temperature of a specific range only. So in that case if the melting temperature of the material is less we can use the primary forming processes and for materials point of view you can see for polymer we do not have too high melting points and therefore the primary forming processes such as injection moulding, compression molding.

These can usually be used for processing of polymers, then we can see if the ceramics have very high melting point so for them it is difficult to form them using primary forming processes because we cannot melt them easily. So we need to look for certain other process which can be used and similarly for metals if you see if the temperature is very high we can go for material removal process we can machine the part into a given sheet.

Similarly if the production volume is very large we can go for deformative processes, it is written here deformative processes, it is already written here, so if the production volume are batch size is large then only we must go for the deformative processes, if the production volume is small somewhere here we must go for the deformative processes because the cost of the die, the cost of the equipment, the cost of the machines may not be justified if we have to deform only a small batch size or only a small quantity of products.

So based on the production volume based on the melting temperature of the materials based upon the type of materials that are going to be used for the product design we can appropriately judiciously select a manufacturing process. So here this diagram has been taken from this book, the source is given and if you can follow this book for specifically this important diagram you can get the further insights into the selection of the manufacturing process depending upon these 2 important criteria of melting temperature as well as the production volume.

You can see for yourself which process are 3 examples I have already taken the primary forming where the melting temperature is less, material removal processing where the melting temperature of the material is high as well as the production volume is low. Similarly the primary forming processes where the melting temperature is less, deformative processes where we have a large quantity or the batch is very very large.

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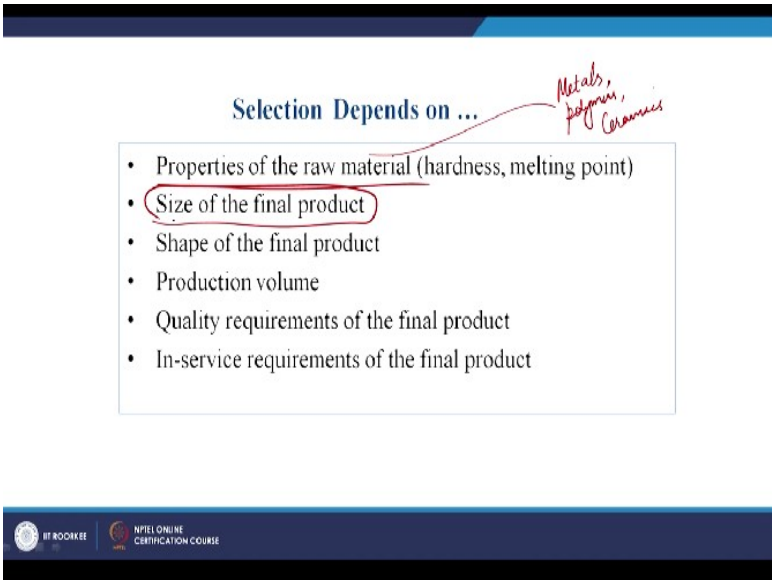

So these guidelines got handy tools for us in order to decide that which process we must be used for which particular application. Now the selection depends upon you can see the properties of the raw material if you see in the previous slide we can see different types of raw materials are there, we can have metals, we have taken an example of polymers, we have taken an example of ceramics.

So different types of materials will ask for different types of manufacturing processes. So for ceramics there will be different processes, for metals there will be different processes, for polymers there will be different processes. So the selection of the process will depend upon the properties of the raw materials, the size of the final product very very important, if it is a small product but different manufacturing processes will give you economic production.

If it is a very large size product a specific manufacturing processes will give a desired output. So we can see simple thumb rule if the size is very very very big you will not be able to make it by machining process because we have to hold the job on the machine and then only you have to machine but you can easily make it by the casting process, so simple maybe rule of thumb that is the size of the product is very very large.

And it has to be made by metal as the raw material it is always advisable to follow the casting process, simple rule, simple guideline it is written over here, but as a my own experience of maybe dealing with these type of courses for so many and it has come to my mind. So large size product mostly we will go for casting, there may be certain exceptions and if you see the syllabus for this course we already highlighted the exception, the applications.

So may be there may be exception that there is large size product but it can only be made machining process, but in general if the size of the product will be large it will be made by the casting process. So the size of the product is important, the shape of the final product is important, if it is very very intricate, very very complex geometry you have to make, it will certainly affect your choice of the manufacturing process.

Sometimes your process with that you are using for making a product like this that can be we can say very very easy to make a not product with this shape not very complicated but on the contrary you may have a other fairly complicated products which may not be made by a

process which you can use for making this product. Similarly in the previous slide we have seen production volume.

The number of products that we are going to produce in the previous slide you can refer back, you can see if the number of products or batch size is large, deformative processes are advisable, quality requirements of the final product we will see with examples and case studies that if you do not use of particular process or a specific process the quality of the product will not be as desired.

So it will certainly effect our choice of the manufacturing process or our selection of the manufacturing process as well as in-service requirements of the final products sometimes also will help us, one an example that is coming to my mind is of self-lubricating bearings. Now self-lubricating bearing you must impregnate the oil during the manufacturing process itself. So that when you put it in service it automatically lubricates the moving elements.

So during the manufacturing process only we have to select the manufacturing process in such a way that you manufacturing the self-lubricating bearing so that in in-service when it is used it is performing its intended functions as per the design requirements. So with this we conclude the today's session I think the session was more in general discussion and we have tried to see that how the processes can be classified.

And in summary I can say that there are 6 broad categories which can further sub categorised into the conventional type of processes and the unconventional type of processes and then we have tried to see that what can be the criteria which can help us to decide that which process must be used under certain or under specific circumstances. In our next session we will try to carry forward this discussion and try to highlight the importance of manufacturing from the product design point of view, thank you.