Manufacturing Processes – II

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Lecture No. 1
Instructional Objectives – I

Young friends you know our subject is Manufacturing Processes.

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Manufacturing Processes II which basically covers processes close to machining. I am A B Chattopadhyay, Professor of Mechanical Engineering, IIT Kharagpur and my contact details are given in this plate. Now you are presently students and after some time you will become engineers, but later on you will be very important part of the society and nation and you have to contribute and take the responsibility to fulfill the national target. Every nation has got certain target, what is that target? Is common to all nations? Growth of national economy is the backbone of any nation. How it can be attained? Improvement of standard of living of the people of the nation. Now standard of living you know is the index of progress and prosperity of civilization and nation. It has to be continuously improved.

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You see the standard of living of Japan, Germany. There are very advanced, progressive and prosperous countries compared to some African countries where standard of living is so poor, but another important target especially for big countries like India having worst population is creation of employments.

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Now Industries are very important part of the country or nation. So they have got enormous responsibility to fulfill the national target. To achieve it to help that, they must have their own goals. What the goals of the industries? Enhancement of productivity and

quality of the products. Second sale of the product. Whatever they produce that must be sold and they have to create the market, expand the market, so that the products are sold. Then, profit is a must that has to be created for the continuous growth and benefit of the society and this really needs to what is called competitiveness which is essentially important especially after globalization of comparativeness and all the standardization, then expansion. Every industry should expand in their production, diversification of production and this is the index of dynamism of the industries.

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Now, we often talk about production engineering and side by side manufacturing science and engineering. They are correlations. The relation between production engineering and manufacturing what is that? Let us see first, what is production engineering? production engineering deals with production of goods, solid goods like furniture, houses, buildings equipment, machineries and so on and services like design, like plan, research, concepts etcetera by best utilization of the existing resources. For MENS' MATERIAL WELFARE for welfare of the human being, briefly MMW.

Now what is really mean by these materials for mens' welfare? Right from the history you will see that most important material or object for civilization or mankind is shelter, housing, then clothing, then medicine, then education, then transport. You see that Japan is the most prosperous and developed country in the world now and how is this justified. The transport system of Japan is the best in the world now. Communication has changed the whole shape of the whole world IT information technology. The tremendous growth has taken place all over the world and last but not the least Entertainment. Yes we are human being, we have got stomach to be filled but we have got a mind also and to satisfy and peace the mind and to keep ourselves alive and here no active our entertainment is also necessary. Though all these things aiming improvement of standard of living. So, all these constituents are necessary for improving the overall standard of living.

Now how to create this MENS' MATERIAL WELFARE where if where from this will come? This will come from the natural resource. First, what we need is natural resource. For example, say there the very primitive days, say pre Paleolithic age people did not know use of agriculture or fire or anything. They found only some say natural fruits, say an apple tree. They went to the tree and found lot of dry apples lying on the ground. They simply picked up and swallowed. When this was exhausted, the natural source at the source exhausted then they had to stretch their hand towards the branches and plug the fruits from the trees. That is the beginning of what is called human effort.

Now, after all the fruits near by are exhausted, and you cannot, your hand cannot reach then, you take help of a stick or a branch of a tree and you shake it and you will get the fruits falling and that is called tools. That is the beginning of use of tools. Now, come to reality. Natural resource really means say the wind or air without which nothing can survive. Then water, heat and light through sun, then plants and vegetables and finally minerals both liquid and solid. Now human effort also includes the animal force animal power then what we mean by tools it is not really hand tool. By tool here we indicate say power plants, steel plants, chemical plants, factories, machine tools and so on.

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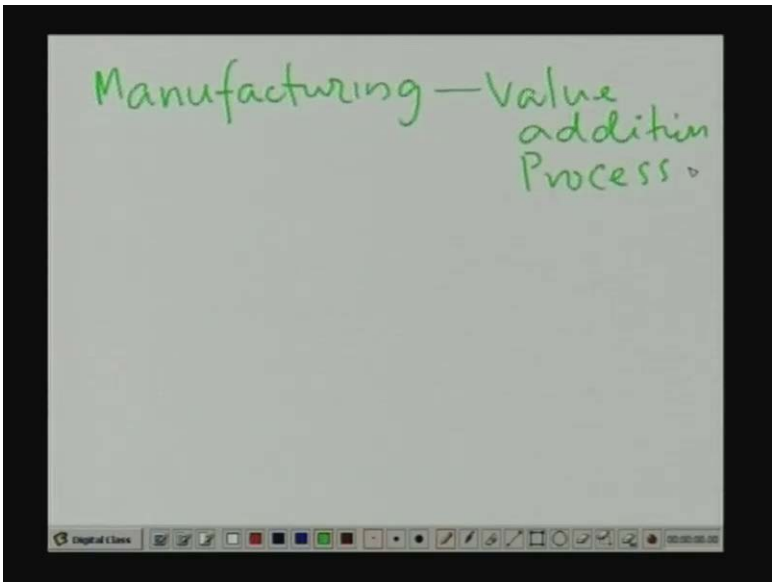

Now, let us come to manufacturing. What is meant by manufacturing? Manufacturing is basically a value addition process. A process of addition of value. So, value addition process. Now, I shall just explain with the help of very simple example.

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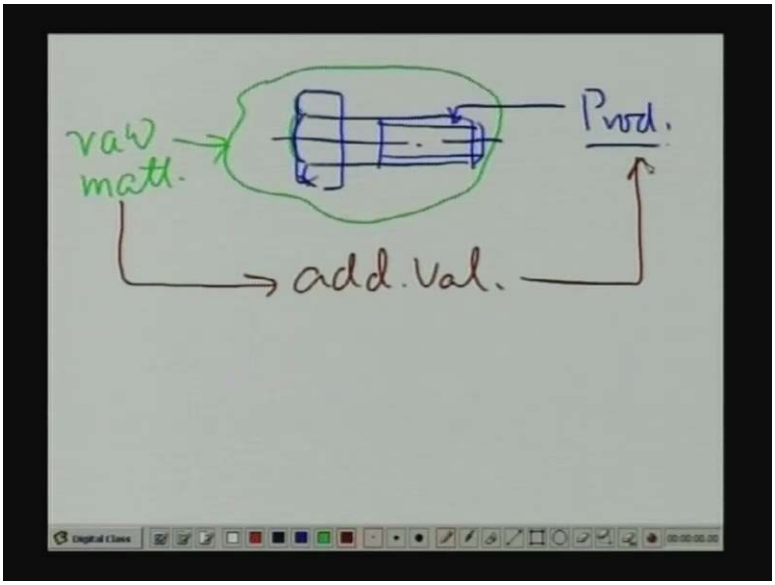

Just imagine a lump of iron may be say half kg weight. What is the use of it? It has got neither shape, no size, no geometry and surface is so poor even the burglars will not lift it. They will hesitate. So it has got no value. It will not be sold even if one rupee. Maximum you can use it for you know as a paperweight or on for throwing on somebody's head for protection, that much beyond that it has got no use. But friend if from the saying say mild steel, a piece of mild steel from here what is this? Everybody knows you understand this is a bolt. Now this bolt has got very much use in many places. It has got values, it has got utility why? Because it has got not only the desired material properties like strength but also the appropriate geometry that is size and shape, dimensional accuracies and the surface quality on the features for which it is really a bolt which can used for fasiling. It has got utility so, it has got value where the raw material which was heavier and bigger than the bold which has no value may be even one rupee or less than one rupee because it had no utility.

So this is the raw material and this is the product. This is the product which has got value. Now here so what has been then so what is manufacturing. So, manufacturing is the process of conversion of a raw material of low utility and almost no value because of having no particular dimension, shape size characteristics into a product of high utility and value because of having appropriate size, shape, feature, configuration, dimensional accuracies and finish. So this is called manufacturing. By the hint of that, what we are doing we are adding value. As a result we get the product. Therefore, manufacturing really means a process of value addition. Simple another example analogy, you are the students under graduate students what is the value? What is the utility of yourself? You are neither you have got no professional knowledge. You have got little background knowledge.

Say, good material may be like steel. You have got and read say some knowledge through school and higher secondary but do you have any professional knowledge. So

what is the utility of you? You are not useful now. You have got no knowledge, no experience, no confidence, no competence, nothing. But, through this four years course you will become engineer. Presently as a raw material what is the value you have minus six thousand to minus ten thousand rupees per month but after four years when you become engineer your value will be from twenty thousand to thirty thousand rupees per month. So, the four years program is nothing but a conversion process. Conversion of a student into an engineer. You as a raw material becoming a product like an engineer with the full knowledge, experience and confidence and competence and what is this institutes, it is a machine and the learning process is a manufacturing process. So this is the good analogy.

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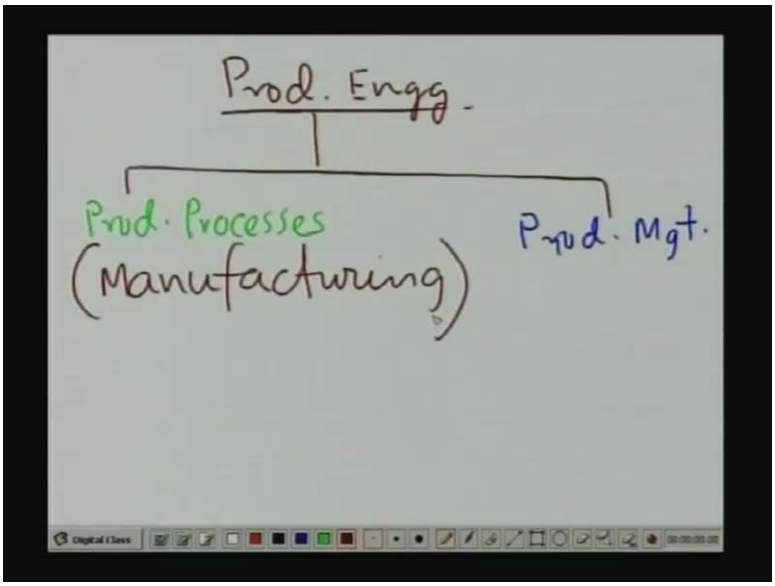

Now production engineering has got two pillars on which it stands. One is production process or processes. Other one is production management. Now this production processes really means, what we are interested of manufacturing. That means manufacturing deals with production processes. Now let me go to a little more detail say manufacturing.

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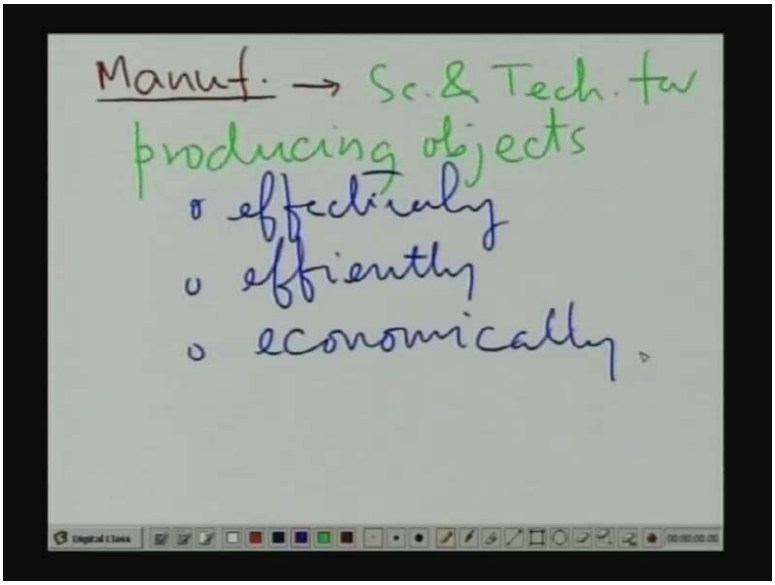

It refers to what? It refers to science and technology for producing objects. Then you should keep in mind while doing so, these has to be done effectively. Number one effectively, efficiently and economically. Effectively means you have to get the work done according to the desired dimensions, finish and so on. Efficiently the same work has to be done quickly with the less effort and less damage and economically with a minimum expenses but how this can be achieved? This can be achieved through:-

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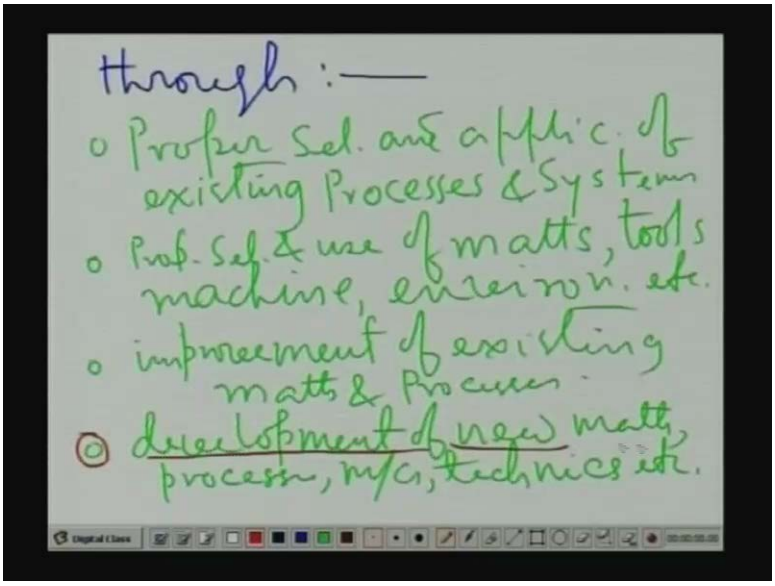

(1). Proper selection and application of existing processes and systems, manufacturing processes and systems you have to use that. (2). Proper selection and use of because there are plenty of tools, materials, environments, machines you have to choose appropriately

proper selection and use of materials tools, machines, environments etcetera. (3). Improvement of existing materials and processes materials and processes. There is enough scope always to improvise these existing methods and (4).The development of new materials, processes, machines, techniques may be conventional or special etcetera. But whenever you do this thing, development of new materials processes machines and techniques. One thing you should always keep in mind whatever you produce you think of is not useful. While doing so, you must remember that all these things should be technologically acceptable.

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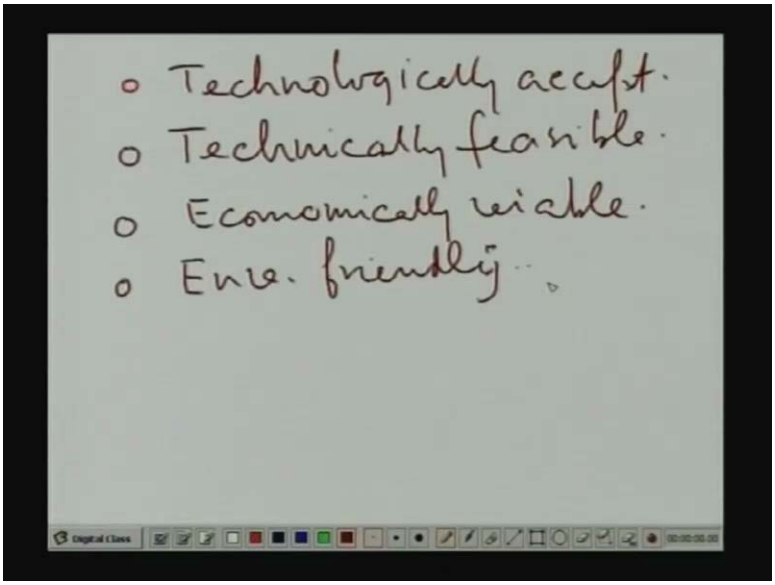

The new material, the new technology, the new process, new system whatever you do that must be technologically acceptable. It should not be abstract kind of thing. It must be real. Second technical feasibility. Many things may be technological acceptable by science and technology but technically may be difficult because of non availability technically feasible. Suppose you want to do something in a very ideal way but the system is not available to you. So whatever facilities you have you have to select the optimum one out of that. So this is technical feasibility. Third is economical. Economically viable you develop something new material say like gold or say diamond all the time that may work better but what about the cost tremendous. So, you should always keep in mind that whatever you develop that must be economically viable. The extra profit or gain it will earn must be more than extra effort or investment you made. That is called economic viability and last but not the least you should never forget the environment friendliness. Environment friendliness or it should be environmental friendly.

It should not create hazards or pollution of the environment. You know this has become mandatory all about the world. Even in our country more than few thousand industries have already been closed down in Delhi. In many cities of the country, only because they are not fulfilling the requirements regarding environment friendliness. They are creating

lot of pollutions of the environmental air, soil, river water, sea water and so on. So, this has to be taken care of. Now friend what is the present status of manufacturing globally?

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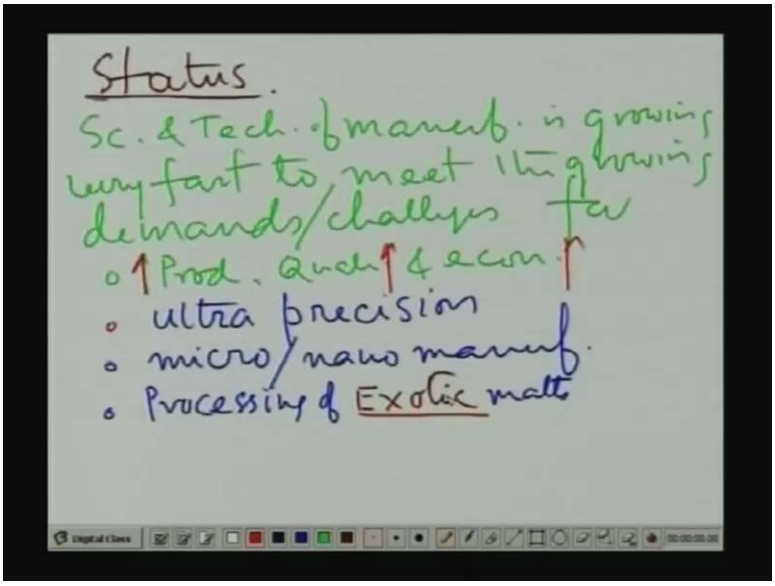

Now the status is the science and technology. Science and technology of manufacturing is growing very fast in an accelerated rate not at the constant velocity. Very fast to meet the growing or increasing demands or challenges. (1) Increase in productivity, quality and economy. So this has to be increased. Quality has to be improved and economy has to be improved. (2).Ultra precision. Now this manufacturing technologies has gone to that extend so for that we can produce in the accuracy or finish in the order of ultra precision in the order of micron or submicron, a nano and nanometer also and next is micro, even nano, manufacturing like.

Say for example, even think of a small robot which seeks degrees of freedom has to be developed which should be so small in size that it can be put into the vein or artery through a syringe and this will go into the through the vein and artery it up to the say head or say brain or say a heart where this will do some inspection as well as surgery. Now, what about the components of that small robot that has to manufactured? So we have gone to that extent micro and nano manufacturing. Another point as I say that science and technology are growing very very fast, it is very difficult to cope up with and along with that new kinds of materials are coming up which are very very difficult to process like forging, casting, machining a very difficult and these are called exotic materials.

Processing of exotic materials which are coming up regularly with the progress of science and technology likes a nuclear science aerospace and so on. But what about this exotic what do you mean by this? As I already said that which is very difficult to process forging casting or may be for example say titanium alloy, super alloy that is a nickel the

super alloy, Inconel, pneumonic. They are composites ceramics these are all exotic materials. These are coming up and getting widely used in the modern science and technology but the manufacturing scientist and technologists have to develop in parallel processes by which such exotic materials can be comfortably and economically processed. Now on the other hand this is about the manufacturing.

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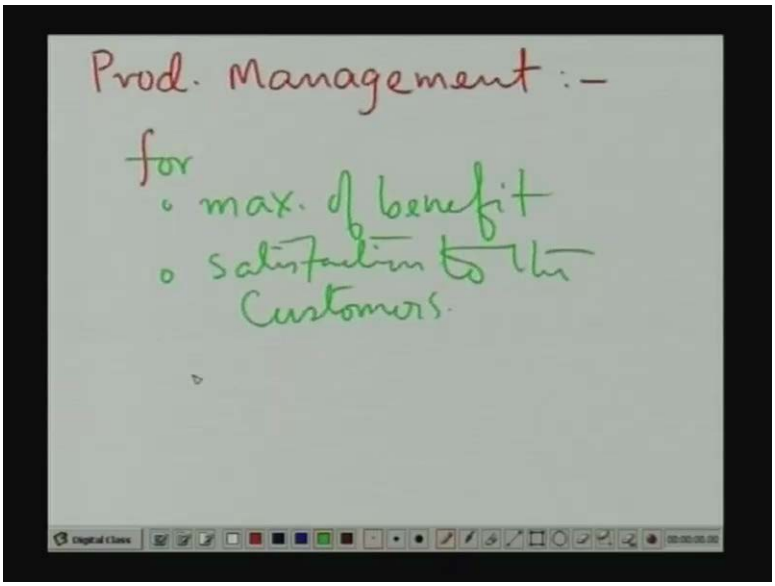

Next come to production management. Though it is not our subject at this moment but, you should understand that, what is basically the role of management, production management in the industry. The role of production management is to make the overall plan of the manufacturing. Manufacturing it does not mean a machine and a job and an operator. Manufacturing means a factory, people, organization, structure, machineries working people, management people then offices like sale then purchase and various things. All these things have to be planned in advance. All these things have to be properly scheduled and programmed, coordinate it, then controlled, monitored and finally optimized.

All these things, all these activities are under the preview of production management. So the production management will do all sorts of activities related to manufacturing for they should optimize. They should not only do that they will do those work in optimum way for maximization or say maximization of benefit. Mostly benefit in terms of money the profit and satisfaction to the customers. But, while doing so they should always keep in mind that they will do it with the best utilization of the resources. So what are those resources with the best utilization of resources?

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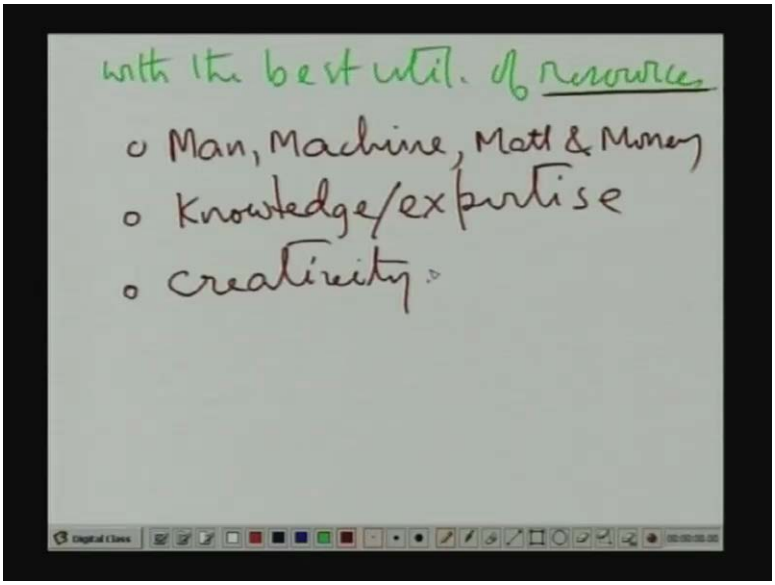

Now what is the resource? (1) By the resource we mean that man, machine, material and money four m's. These are the first primary resources. Now, (2) next resources knowledge or expertise available resourceful people and then the people they are worst experience. They are creativity. Yes creativity or intellectual ability or the creativity or the creative minds. These are the basic resources which have to be exploited to the maximum extent to earn maximum benefit and provide bags of satisfaction to the customers by planning organizing, coordinating, monitoring, controlling and optimizing the resources.

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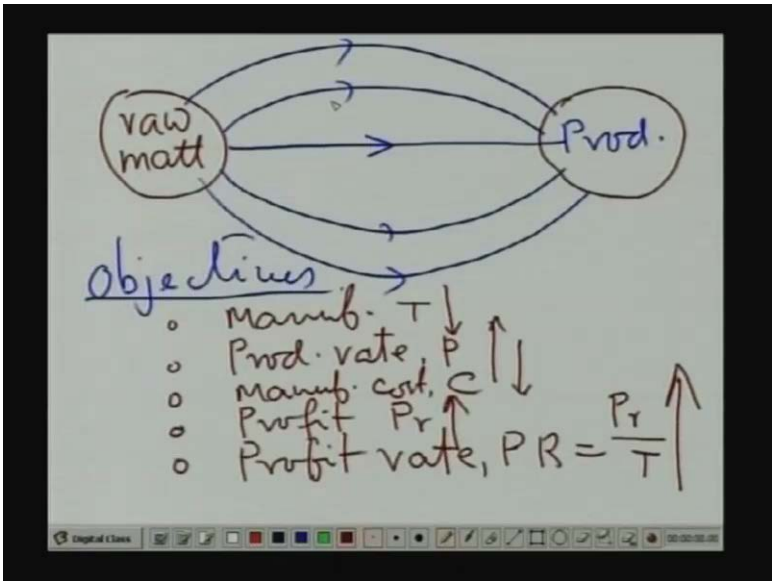

For example, Let us take an example. See this is a raw material. This has to be a lump of iron may be this has to be converted into a product. So it is a conversion. This has to be converted from low utility to high utility. So on low quality to high quality, from low value to high value. So this is the manufacturing process. It has to be converted. But friend while you are going from say Kharagpur to Calcutta is not that you have to go by train all the time you can go by road also. Similarly, within a city you can travel from one place to another place by train, by air by other transports there may be various methods.

Similarly, the conversion of raw material from one raw material into a product can be possible in number of roots or number of processes may be casting, may be forging, may be rolling, there are may be other roots also. Now when there is only one option there is no problem but when there are so many options the problem arises which one has to be selected. We have to select the optimum one which one is the optimum? How shall we decide? This will be decided based on the objective what is objective? The objective is say manufacturing time of production. So, this has to be minimized reduced then production productivity or production rate say p this has to be enhanced. Cost manufacturing cost this has to be reduced as for as possible. Profit say Pr, this has to be increased.

Now simply increasing profit is not enough. What is more important? profit rate. If you make a profit of twenty thousand rupees in one year that is not enough but if you can make profit of five hundred rupees per hour that is more significant, profit rate say PR. This is basically profit divided by time and this has to be maximum. So either one or some of the objectives have to be fulfilled while selecting the roots or optimization. Now all these things should be decided are under the jurisdiction of management. It is an example.

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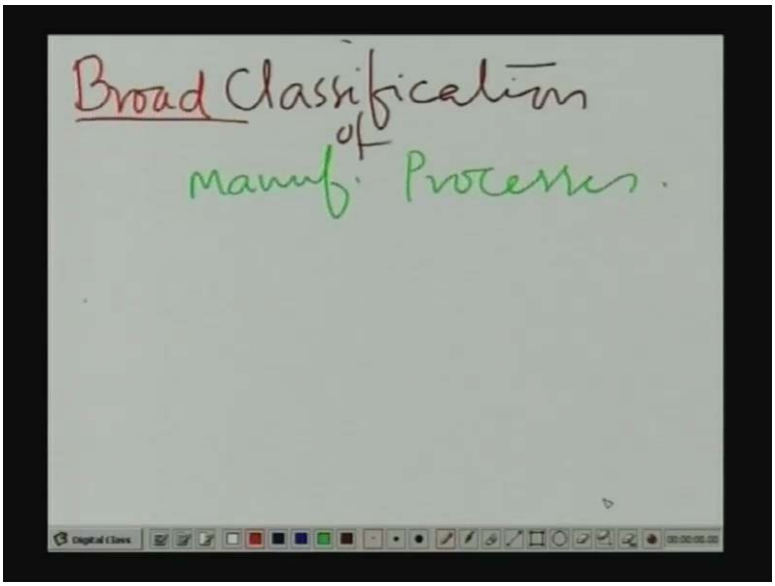

Now Classificaion. Classification of manufacturing processes. How many processes exist? Nobody can tell correctly. Nobody can tell correctly any time because the number is so large and it is increasing so fast. At any part of the world is very difficult for any person to keep the track. Say from this chair I do not know that what new process has been in Japan or Germany right now within the last two hours. It is impossible. It can be thousand processes. Then what is the solution how shall we classify. So instead of saying classification we should say broad classification. So, all these processes can be broadly classified into some groups of certain features or characteristics. Now, I shall show you.

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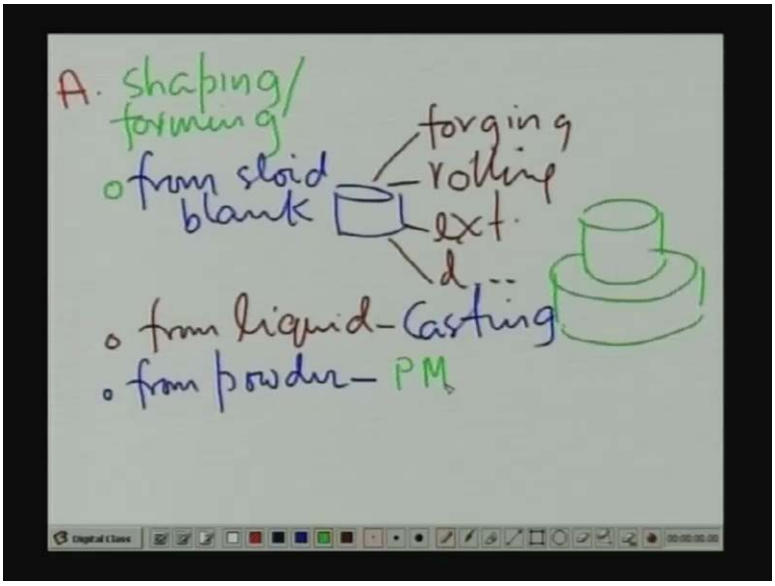

Say A. Shaping. The first category shaping or forming is also called forming. Suppose there is a product, a metallic product may be brass. This has to be produced with the proper dimension as for as possible. Now this can be done by shaping or forming. Say first method from solid blank. You take a solid blank a rod or something and then this will be converted into this. Now this can be done by forging, rolling, extrusion, then drawing and so on. Second is from liquid you take the raw material in the form of liquid to get this product. Now here you can understand this is casting. Third is a removal process. Sorry not removal process, from powder using powder as raw material. This product has to be produced. So what is that technique? This will be powder metallurgical process simply PM is a powder metallurgical process. So it is one group shaping and forming.

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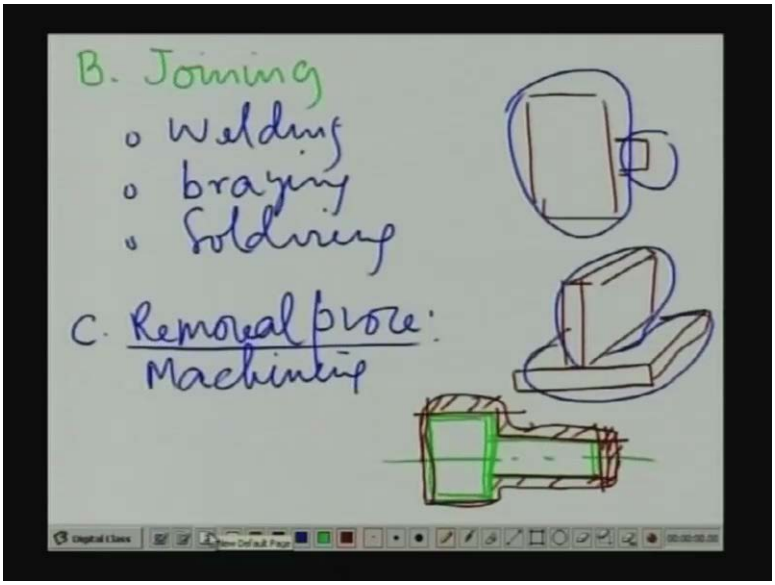

Now next B, Joining process. Joining say a product has to be made like this. A big part with a small part as a protrusion or say a T joint like this. T joint of two steel plates. Here doing these things by other processes will be uneconomic will take more time and wastages wastage of time and effort. So this can be done by making this piece separately, this piece separately, this part separately and you make this part separately and then you join them simply and what is joining processes welding, brazing, soldering. There are other methods also like an adhesive joining and other methods. So this is the joining process.

Now see removal process. This is actually machining. Suppose you want to produce a product like this. A rod with two steps one the larger diameter, and the small diameter and these finish will be perfect. The dimensions will be uniform and to the correct values and so on. So how do you get it? So first what is done? A blank is prepared, a rod is prepared approximately to the dimension and this can be done by forging, by casting, that is called performing process but that will not give the appropriate dimensions. Then, what you do? you remove this material first. You remove this material. you remove this material from here. You remove this material then you remove this material gradually and then you remove this material. So after removing the material from all around what remains the job with the perfect dimension and shape and surface finish. So it is a gradual removal process of excess material from the preformed blank and this is called removal process or machining.

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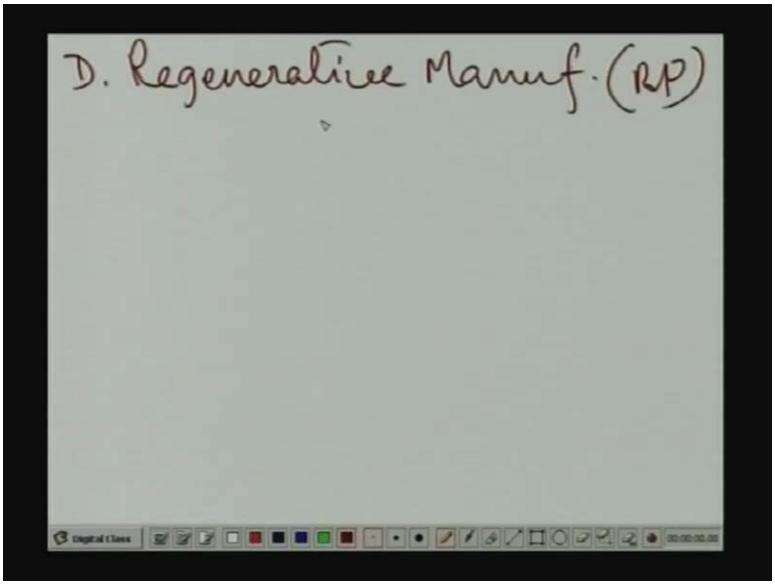

Now another modern process D is regenerative manufacturing. It is also known as rapid prototyping process. Rapid proto is one of the type of regenerative manufacturing. It is a very modern process and is very excellent process is very very fast method and it can be used for best production or quick change over from one design to another.

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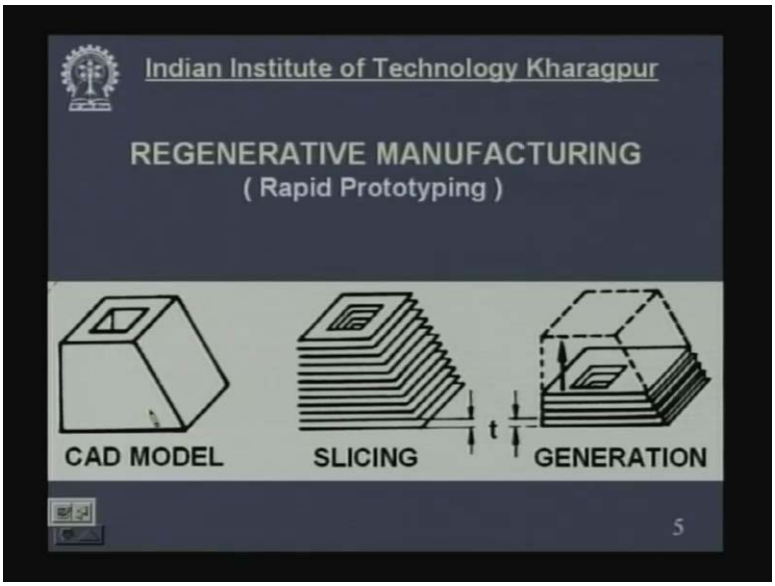

So simple example here you see that, suppose this is the product which has to be made or manufactured. A solid body of metal say brass and then first of all, this job has to be drawn properly not physically but this has to be drawn to the computer by CAD, AutoCAD or some other CAD model. So you draw this thing in a computer or you can get a solid job and then by when a proving or measuring the dimensions you can put the

store the data in a computer and then make this solid model. After this conceptual drawing, just imagine that you slice it. You slice layer by layer just like this layer by layer. So what is happening? It is nothing but a sheet. So it is a top sheet will have some hole and this is hole is continuous. So each sheet will have some hole.

Now you make this first sheet. So this is called slicing but it is called virtual slicing. It is not really done. It is done virtually and through the computer and stored into the file in each file. So each file one file corresponds to one slice and this slice has to be manufactured separately. Suppose this slice is made then you make the second slice then you make a third slice. So all these slices will be made by various methods and then you just simply stag them and joint them you get the product. So this is so quick. So this is a prototyping. This can be made within one hour or two hours but what the process is you see this can be done in number of ways.

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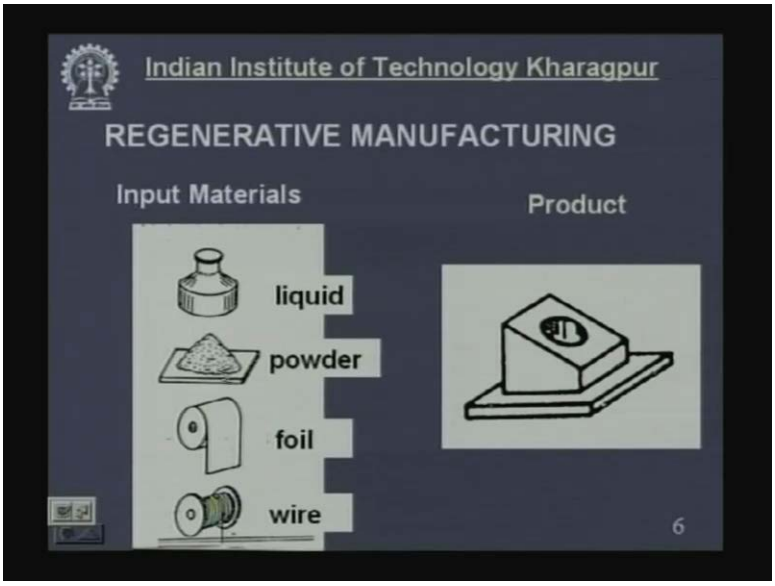

Suppose this is the product, a complicated product. This can be done by taking raw material in the form of liquid. If you take it take in the form of liquid, this is called stereo lithographic method. You can start from powder or the selective sintering process. You can start from the foil as a lobe layered manufacturing by metal and wire you can use the wire as the source of material and using the FDM process, you can gradually produce it. Now next is machining. Now let us come to machining.

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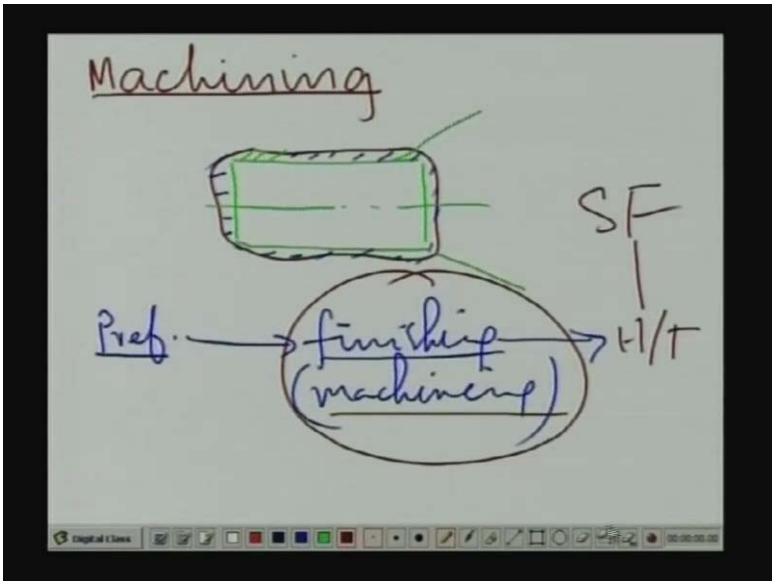

Machining is also a kind of manufacturing process. For example, say here is a product. This is the preformed blank produce by costing or forging and somehow like this and then you produce you want a job of this shape all right. Now, machining means conversion of the raw material. This is the raw material into the product by removing the excess material. By removing the excess material gradually in the form of chips and then you get the product. Actually in any manufacturing process what are the steps? Major steps are performing like casting, forging, rolling. But this process never imparts the desired dimensional accuracy and finish.

So it has to be subjected to finishing to appropriate dimensions and surface quality and this is called machining. The finishing or semi finishing to a product of good dimension and finish has to be done and after that if necessary this will be subjected to say heat treatment, may be super finishing by grinding, honing, lapping and so on. But semi finishing and finishing may be accomplished by what is called machining. It is essential for what why it is necessary machining. As I said that by performing what we produce does not process the desired dimensional accuracy and finish for which they cannot serve the purpose. Suppose you want to have a bearing.

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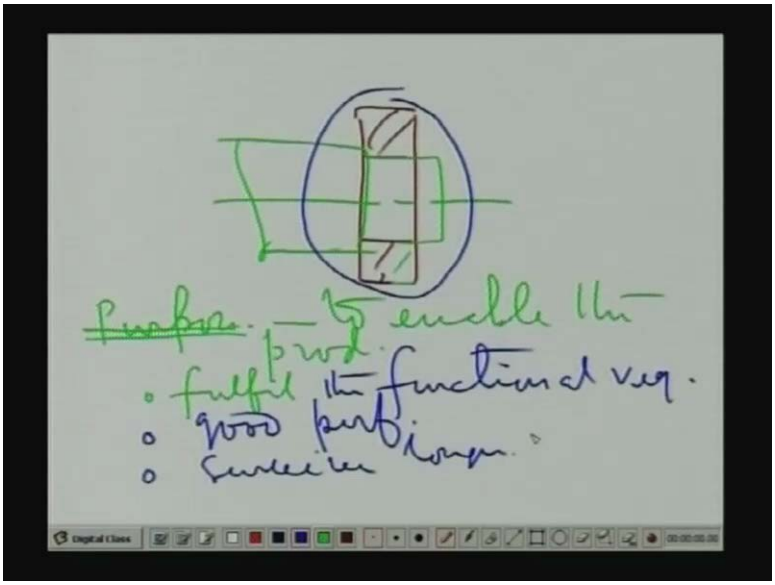

This bearing has to the mounted on a shaft. So the bearing has to be a perfect dimension but by performing by casting, forging you cannot get it. This has to be finished by machining to appropriate dimensions and finish the purpose to enable the product with the purpose of machining to enable the finished product fulfill the functional requirement functional requirement in for this example here fitting. Fitting the bearing on the shaft, that is the functional requirement. Next one is good performance. Good performance or improvement of performance. More and more finished the product will made it will perform much better and to enable survive longer or provide service longer service or survive longer. So machining is essential to impart functional ability to the product, then good performance of the product and prolonged service life of the product. Now what is the principle? Now what is the principle of machining? For example, say this is a plate.

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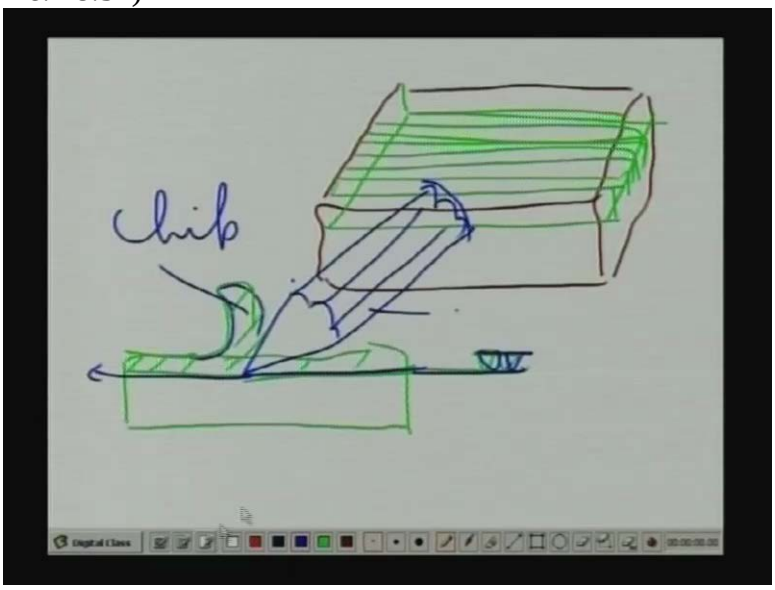

Now you see all the dimensions are not perfect. The surfaces are not flat and now what you have to do that this top surface has to be flat and smooth and that has to be done by removing the top layer by machining and this layer will be removed strip by strip. One strip, then another strip, then another strip. So by number of strips gradually, the top layer will be removed. Say if I see from the front view then this is the top surface and this is the product. Now, this layer has to be removed to produce a flat surface. Now this can be done if you put by chiseling operation.

Suppose you just chisel then, this material will be gradually removed in the form of chips. So this layer or material will gradually get removed by this process and this will be perfectly flat and this is the finished surface. This is the direction of motion of the cutting tool. This is the cutting tool and this is the layer going to remove. This is called chip. So this is the machining.

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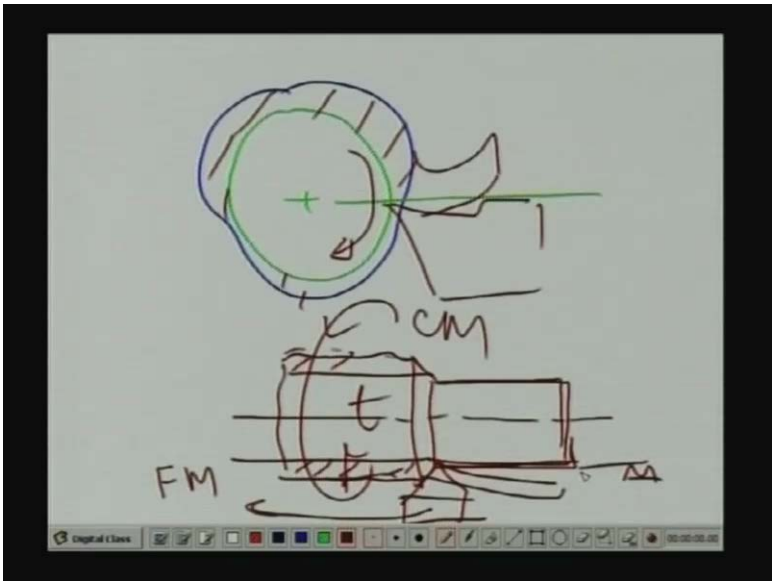

Another example, say here is a rod. You want a product, a rod. A perfect circularity but the raw material is very bad. So you put a cutting tool, then you rotate this blank and then this excess material will be gradually removed in the form of chip. This is another example. Then say there is a rod. You have to finish to a proper dimension. There is a rod that is irregular size and shape but you have to produce a finished surface, good finished surface, this will require a cutting tool. This is the job has to be rotated called cutting motion. The tool has be moved in this direction called motion and this is called depth of cut t or depth of cut. So you are producing a rod of a good dimension straightness etcetera from a raw material by removing the excess material in the form of chip. Now the machining requirements, what is the requirement to accomplish machining?

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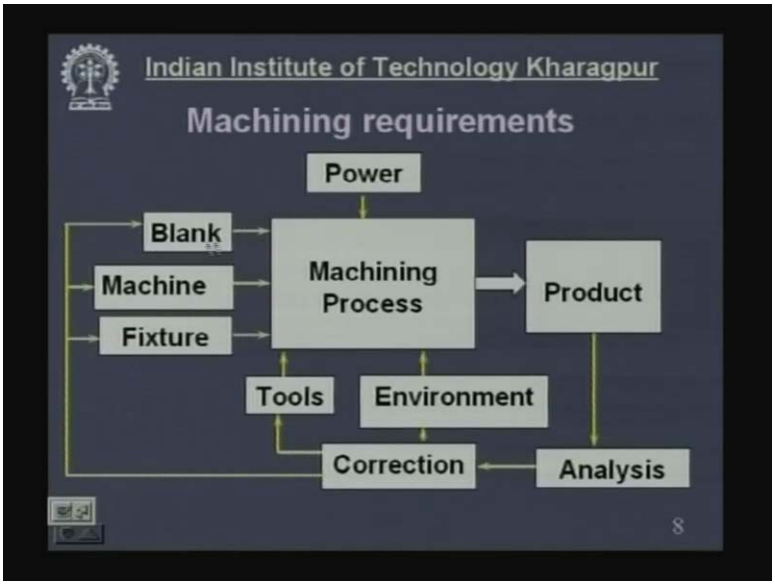

For machining, the machining requirement to complete a job some machining processes required. To accomplish the machining process what we need is a machine. Say machine to lathe or billing machine. Next we did the fixtures, the job holding devices, the chuck for the tool holder, tool post. To hold this job and tool family then we need a blank or raw material to be machined. If you do all work and forget to bound the job the blank nothing will happen. Next comes the cutting tools that have to be fitted power the machine has to be put or the power then environment if necessary apply cutting feed for cooling and lubrication you get the product but whatever is produced will not be a product it may lag quality and productivity.

If you are not satisfied then analyze what is the reason. If satisfied okay. If you are not satisfied then you analyze, what is the reason? Identify the causes and after identifying the causes you take some corrective measure if there say the tool has to be changed or the environment has to be adopted or changed or the blank has to be changed the machine has to be reconditioned or fixture has to be reconditioned. So these are the essential requirements for machining work. Now what is the definition of machining?

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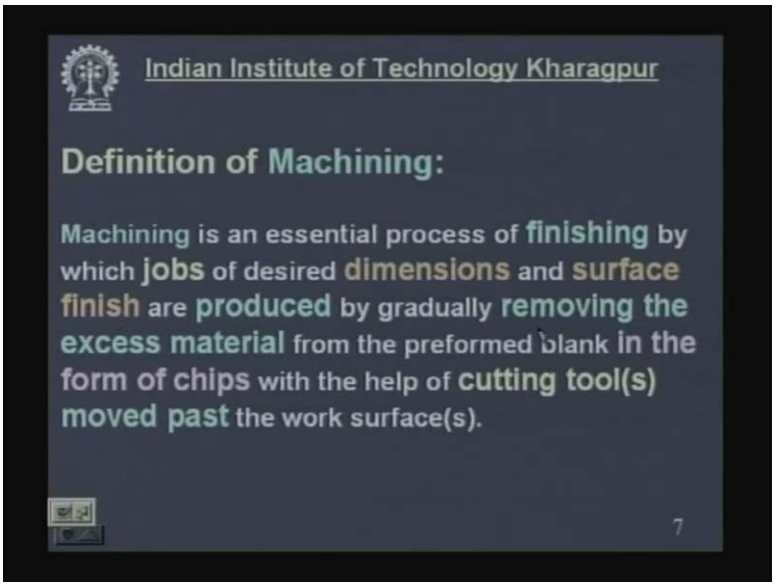

Machining is an essential process of finishing by which jobs of desired dimensions and surface finish are produced by gradually removing the excess material from the preformed blank in the form of chips, with the help of cutting tools moved past the work surface. So is essential feature of this process is the dimensions good dimensions and surface finish by removing the excess material in the form of chips with the help of cutting tool.

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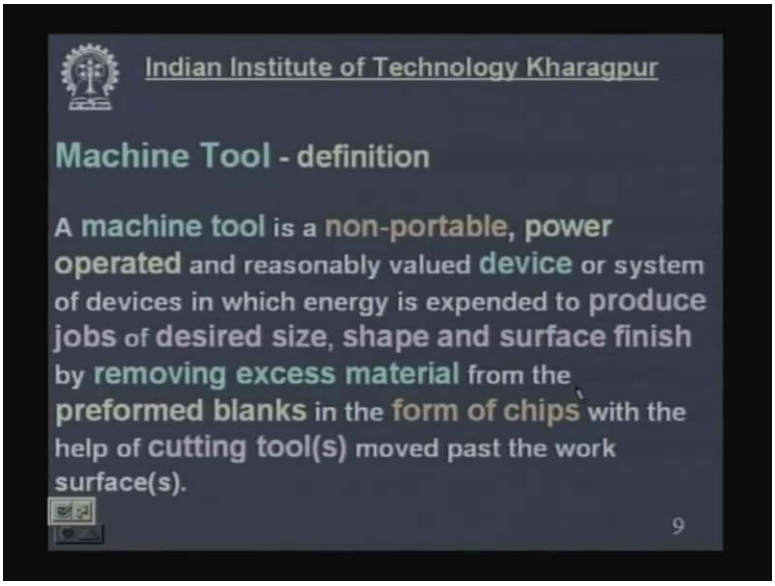

Now what is machine tool? This work has to be done in machine tool. The machine tool is a device in which the job and tool have to be formed, where it the motion and power have to be transmitted from the source of power to the tool and job. Then control of the

speed feed and depth of cut. These are the major activities of the device called machine tool but what is the machine tool definition. A machine tool is a non portable power operated and reasonably valued device or system of devices in which energy is expended to produce jobs of desired size, shape and surface finish. By removing excess material is just like machining from the preformed blanks in the form of chips with the help of cutting tools moved past the work. So the bottom part is purely machining. So machine tool is a device of non portable power operated. So reasonably valued were machining activity will be accomplished.

Thank you.

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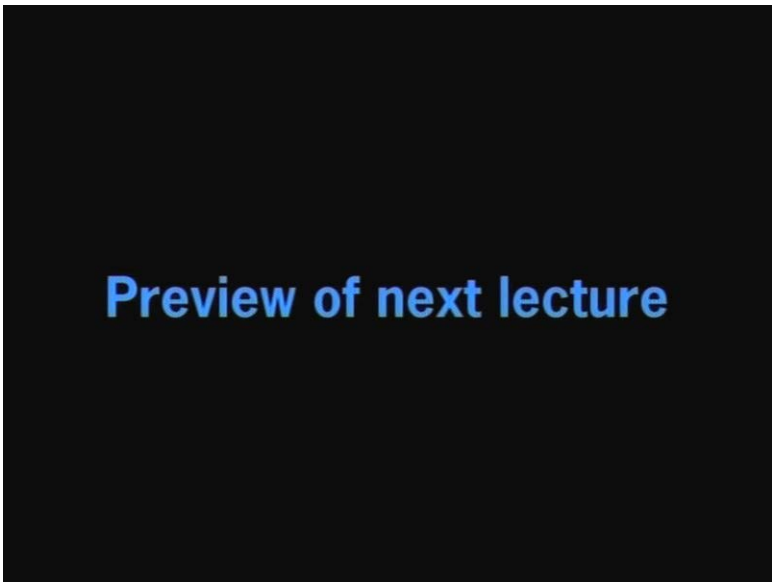

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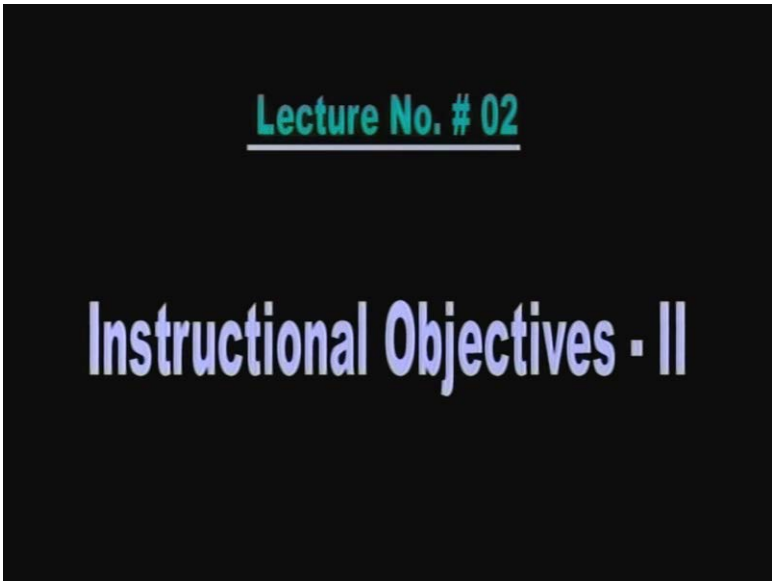

Friends our subject is manufacturing processes – II

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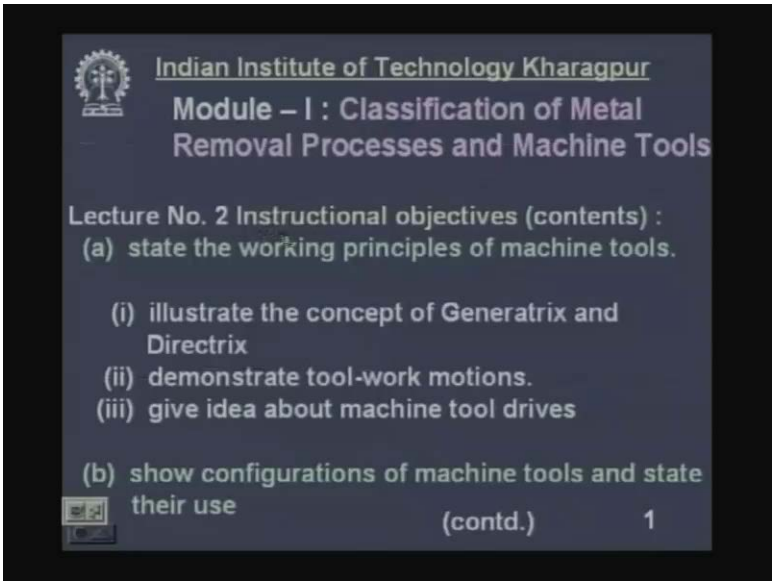

and we are continuing module – I: Classification of Metal Removal Processes and Machine Tools and this is the second lecture under the Module - I and the content or instructional objectives of this lecture No.2 (a) states the working principles of machine tools. The basic principles under that (i) illustrate the concept of Generatrix and Directrix. (ii) demonstrate tool work motions. (iii) Give idea about machine tool drives.
(b) show configurations of machine tools and state their uses.

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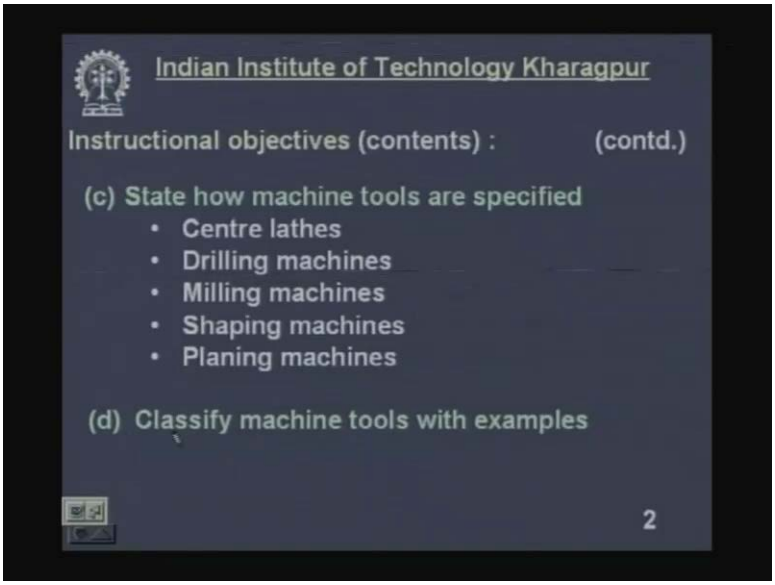

(c) State how machine tools are specified. The conventional machine tools, center lathes, drilling machines, milling machines, shaping machine and planing machines and last
(d) Classify machine tools with examples. Now say the working principles of machine tools

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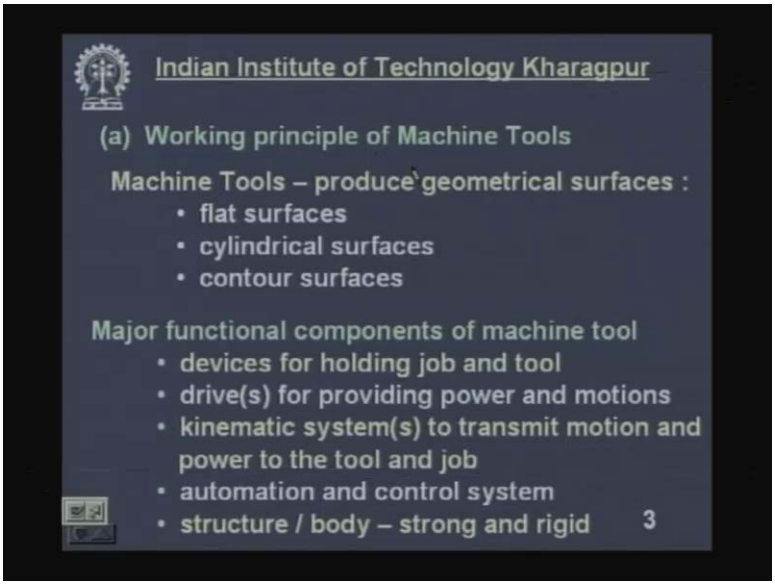

I remind you Machine Tools - they produce geometrical surfaces. This was mentioned in the previous class also. Now when you say geometrical surfaces we mean flat surfaces, cylindrical surfaces and contour surfaces which can be mathematically expressed and redrawn according to program. Only those will be called geometrical surfaces.

Now major function, functional components of machine tools - A machine tool comprised all machine tools will be comprised of some common features which are devices for holding the job and the tool. For example, in lathe those jobs are held in chuck or the driving plate, tool is a tool holder or tool post. Next drives, all machine tools require power drive for moving the tool and the job. Now the kinematic systems means the change of mechanisms to transmit motion and power from the source that is motor to the tool and job and these mechanisms comprising the kinetic motion system can be belt pulley system can be chain and sprocket can be gears, warm and warm wheel, ratchet fall and rack pinion and so on. Next is automation and control system. Some machine tools are semiautomatic or automatic. So some automatic features are there and control system to control the process parameter speed, feet, depth of the curve.