Enclosure Design of Electronics Equipment
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Lecture - 49
CAD in Layout Drawing

Last time when I left you I said the very complex nature of packaging has now moved on into the more sophisticated professional domain, where trained engineers or packaging specialist are needed for carrying out the function.

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So, I will may be I will start with the usual things what you know. This mouse looks relatively (Refer Time: 00:47) and simple. Actually a tremendous amount of effort has gone into it, including the smallest thing is about; a battery. Actually, it is a cell; a single cell is a battery, so you see here that every small detail has been taken care of very carefully and perhaps you will notice, you see this small dock here; this is where we park the RF receiver and then because of various constraints, in a very peculiar way it is kept at an angle. This has been you know inserted at an angle and then you have the actual sensor and these things slightly offset.

Next time, I will bring you a mouse which I will open and show you and then they have also included a switch; though it has a sleep function. And then other side if you see, tremendous amount of detailing; detailing beyond belief, just like you have doctors

without borders.

We have anything is everything fits miraculously and it works. I thought, I will now introduce you to a little bit of this stuff which we call CAD; do not worry, does not seem to work; we will start here everything.

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Now like so many other lectures in the academic field which talk a little about anything including engineering materials, including simple thing like; what an LEDs; Light Emitting Diode, the scope is very vast and often we end up things like can there be a blue LED which of course, includes you know physics and all that then eventually some answers and then the teacher knows the right answer. And then you set a question paper and then you see at least; whether the person who has gone through it and has understood way of the thing.

The underlined thing at the back is the approaches more appropriate than the correct answer and precision. Now, in the case of our packaging things have changed a little; the constraints are known, the evaluation criteria are known, but the solutions are not the same; no two solutions are same. I have given you a example of a mouse here; suppose somebody were to write a book about how to design a mouse and then the person will tell you this sensor has to be here because that gives a mental image and all that; is true to a certain level.

Beyond that a lot of it is because of the production constraints; this is where computer aided design gets its features and so on. Now, if you look at my presentation; I am going to tell you a little about CAD; not everything about CAD and this is not about how to design a CAD packager or anything; it is about saying what is available out there and then one example of some GIF animation, I would like to show you.

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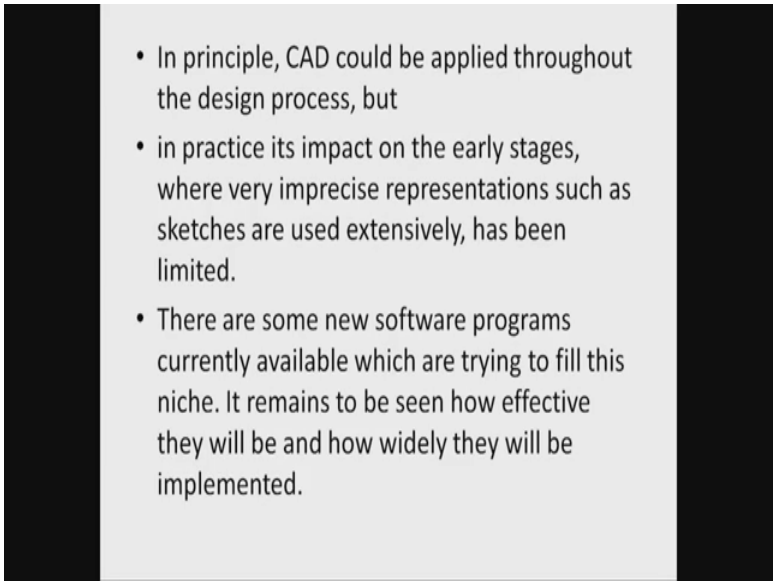

Now, going back to the next slide; the reference I have given at the bottom saying, this where I have taken it from, but I wanted read the original and also read it along with me. In principle, CAD should be applied throughout the design process; so, in that you start and go all the way up to the end.

So, it looks like where relatively established good known products are there; a simple example could be a mobile phone or even the mouse has changed quite a lot. Because if I show you another mouse, where the thing is the whole thing is different; but when you are doing creative design, you start with the imprecise representation; sketches which are tough, it is not easy.

For us just like that to make a sketch; though several sketch software's are there and then, in fact I have a graphic band; just used by illustrators so that we can make things and all that; is a lit illustration software, goes to input the start of the remaining designer software. So, my slide will show you that there are some new software programs currently available, which are trying to fill this niche. It remains to be seen how effective

they will be and how widely they will be implemented. Reality is, I have seen both had some (Refer Time: 06:48) people which you know who go about designers, who sketch on these what you call almost like a white paper, but on a screen and then eventually they are part of the team, they move on to the next stage.

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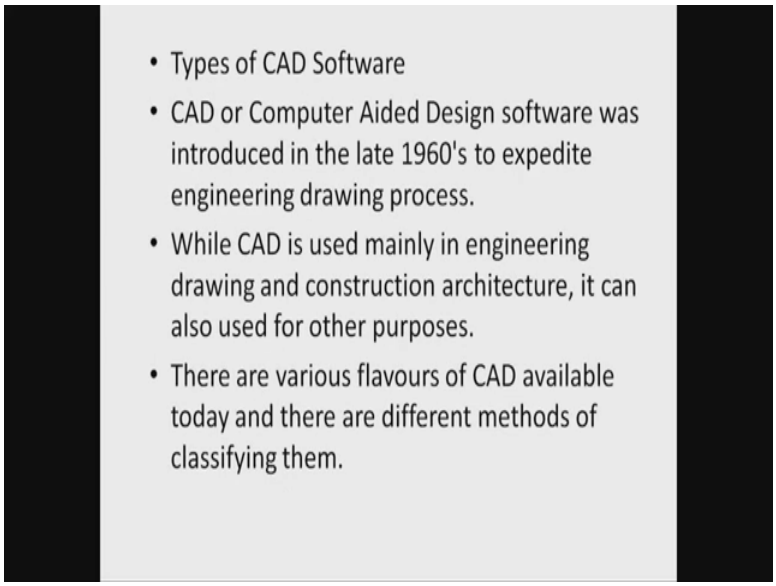

This a little boring and dull, but then you can always get back and read it once again. So, these are around 20 or 25 slides and I want you to just read it along with me. Computer aided design was introduced in late 60’s to expedite engineering drawing. By definition, the word design here probably meant not analytical design, but more little about drawing. So, we have a small what you call; semantic I will not call it any issues; small change in semantics.

Computer aided design is also meant for doing analytical design of a known configuration. You have a known configuration, now you do an analytical design and then you make sure that these; there will not be any surprises when the product is made. First of all, it will not be under design; something need not break, similarly it is not wastefully over design; got my point? There analytical design is critical, but in the case of our thing, it is a lot to do with simple geometry. So, one example of the geometry and all that I have worked out I will show you.

When CAD is used mainly in engineering drawing and construction, it can be used for other purposes. So, in this case; our packaging still has a lot to do with engineering

drawing and things related to fabrication. And the moment drawing goes to fabrication from there, it goes to eventually computer aided to manufacture. While originally drawings are only about taking a drafting board, drafting machine and then maintaining that things are in proportion to scale and all that.

Eventually they have moved over to the shop floor and in a parallel I will not call it universe in a parallel effort. The moment injection molding came about, part of these drawings are also being used by injection molding people. Then suddenly you will notice that traditional engineering drawing where you have three view representation, had its place, had its day and even today old drawings continued to be made like this.

But as you move on, you will notice that we have entered the world of 3D and you create a 3D entity or a 3D object and then try to extract the views and the dimensions back with it. So; obviously, like all other any computer automated thing; it is all about how to expedite; you have seen this know; sorry how to expedite the engineering drawing process, make it faster.

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So, if it is a thing like a engineering building; so obviously, a certain details to be added and then they are repetitive. Simple example I can give you are the doorways and window frames and so on and hardware related to plumbing, hardware related to electrical safety and then certain norms about agress and ingress into the building.

How do you get out in case of emergency and all were easy to check, if it was kept on a CAD. This thing eventually, it all moved on to; so, many types of CAD are available; so some of these they have been taken from two sources. So, both of them are one is have a acknowledge in the first line, the second one eventually I will show you; it is from the mechanical engineers handbook and so on.

Originally the very very earliest thing was so called 2 dimensional CAD is a pioneer of CAD software and was developed in the 70's; major auto, aerospace and other companies developed in house to automate repetitive drawing. 2D CAD relies on basic geomagnetic shapes like lines, rectangles, circles to produce flat drawings. These types of software have been first developed way back in the 70's. Autodesk is one of the pioneering companies that has played a significant role in developing this software. But it does not mean that the only persons, the others this people probably know they released it others are also having a thing, but by definition in house.

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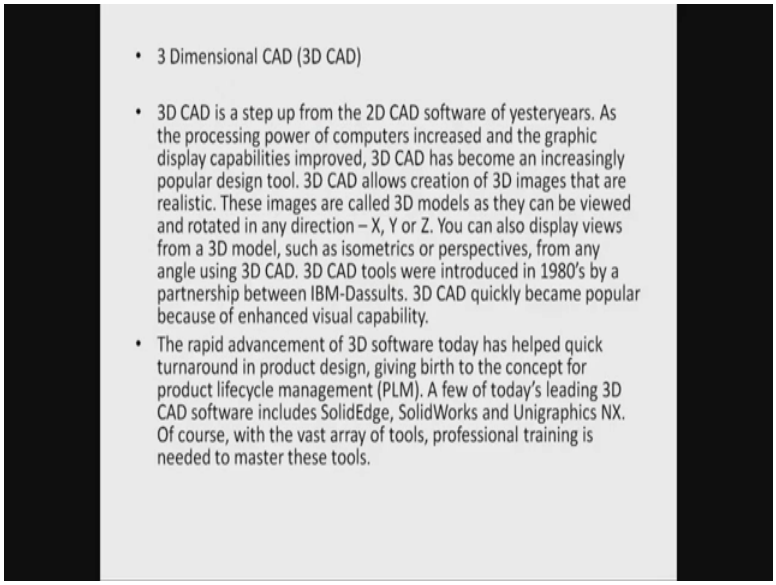

Next very large thing is the 3 dimensional CAD is a step up from 2D software of years, as the processing power of computers increased and the graphic display capabilities improved; 3D CAD has become increasingly popular design tool understood.

We have two things here; the word design is used as both something which aids in a drafting, as well as something which aids in 3D design thinking; saying can we play around all the entities and can rearrange them. 3D allows creation of images that are

realistic, they are 3D model as they in be viewed at rotated in any direction; X, Y or Z; you can display views such as isometric perspectives.

Any angle using 3D CAD; 3D CAD tools were introduced in 80's, but when so many others companies. So, at the end there is a big list of these things, so we have Siemens, we have Dassults and then we have of course, Auto desk something and it will show you so many things. The rapid advancement of 3D software has helped quick turnaround and product design, giving birth to the concept of full product life cycle management. So, we have Unigraphics NX, SolidEdge, then Solidworks all are available which will do anything you want.

Product design does not start and end with making a file; I suggest before you listen to my version of what PLM is; read up just type PLM software and see what is the application and all, it is slightly beyond the scope of what I am going to talk now.

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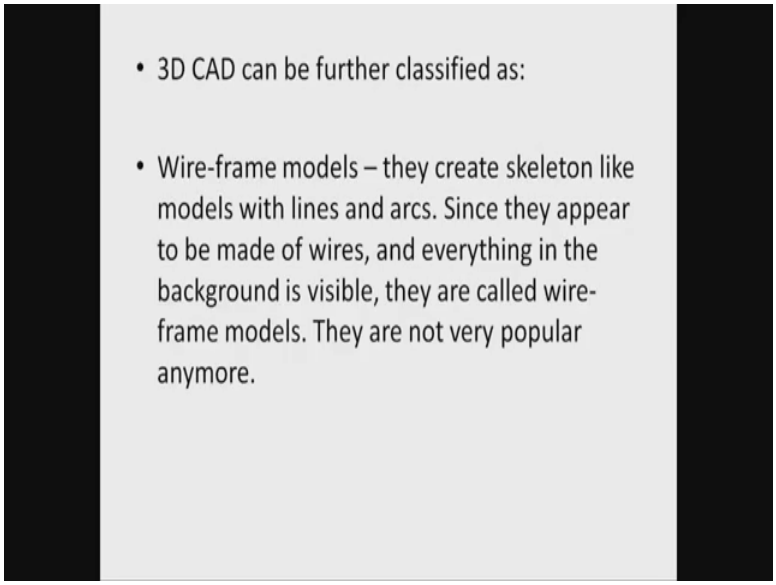

Here comes the very interesting this thing about it saying; simple wire frame models, they create skeleton like models with lines and arcs. Since they appear to be made of wires, everything in the background is visible, they are called wire frame; they are not popular anymore.

But in the initial stages it might sense because it follows a little like our what you call school, classroom representation; is somebody what ask you to make cuboid or parallel

(Refer Time: 15:15) object what will you do; you will try to draw four lines representing the top surface and then extend the vertical edges and draw something more which are joined in the front. Invisible ones are put in dots and you can get; this is a very easy way of his thing.

First time when you are taught how to draw; you are very happy, you will not understand what a dotted line; in due course this is stuck or it is retained in the brain. So, intuitively when somebody ask you to draw; you will probably draw with the visible lines all in the front and then dotted lines to show how the back is; works, no problem at all. But imagine if you have to take a cube and then see it exactly in one what you call isometric view; you will end up with the fantastic hexagonal representation. Very difficult to make out, you will have a trapezoidal thing, there another trapezoidal, another trapezoid there with something joined here will be wondering what the object is.

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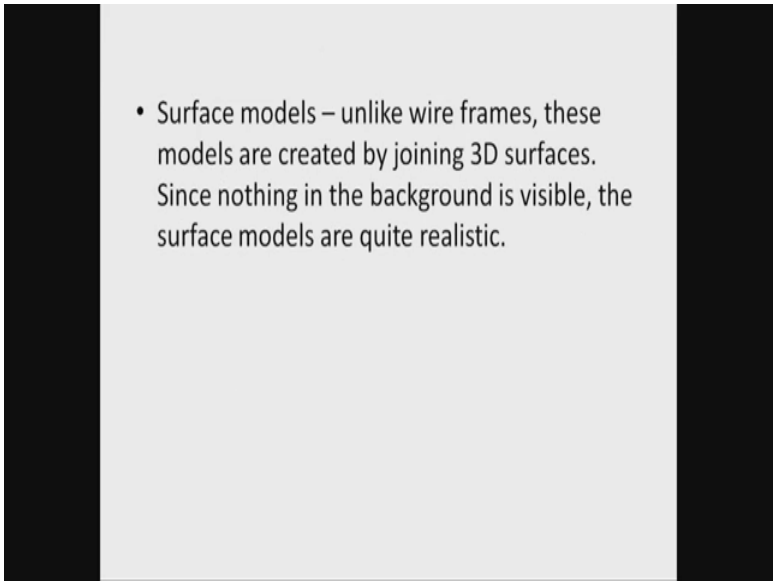

So, this stuff came about saying; it is not that convenient as we do. Now, if you take that object and try to project it; it still did not appear so good. Surface models are slightly better; to the extent that in real life when you see an object, example I will show you this; wireless device I have. What you see here is a surface and which have pointed out earlier; though it is a dark colored object; white highlight has been captured, you see here.

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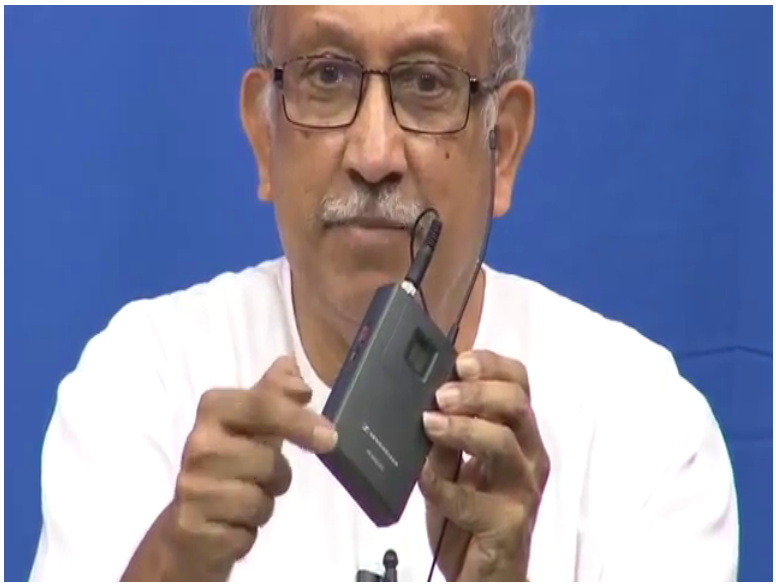

You have see a beautiful highlight has been captured here because of light shining and then the movement, you have a circular; I am sorry where two edges meet, where there is a cylindrical surfaces formed; the surface properties make it appear, you have seen here in this object it is there. Only it was if it were a completely black, non reflecting surface; then you may not be able to make out and what it is.

So, here a surface modular like if you have a complex surface like this; in reality you cannot make out. So, if you see some of those; what you call gag tv shows or funny tv shows, sometimes they give what looks like you know very light this thing and then inside they would have put a brick or something and then suddenly when they let go of it, it falls. Alternatively, they take something which is really light and an actor acts as if it is a heavy object and then when they give it to you; you suddenly feel that there something missing in it.

The important thing about surface modular is, it still a collection of surfaces with the edges kept close together and if you are lucky and if they get packager interprets that properly; it looks a little like a an object. But you should remember all computers still have a precision while they try to put things together. So, sometimes the edges do not get welded then you can see through the things.

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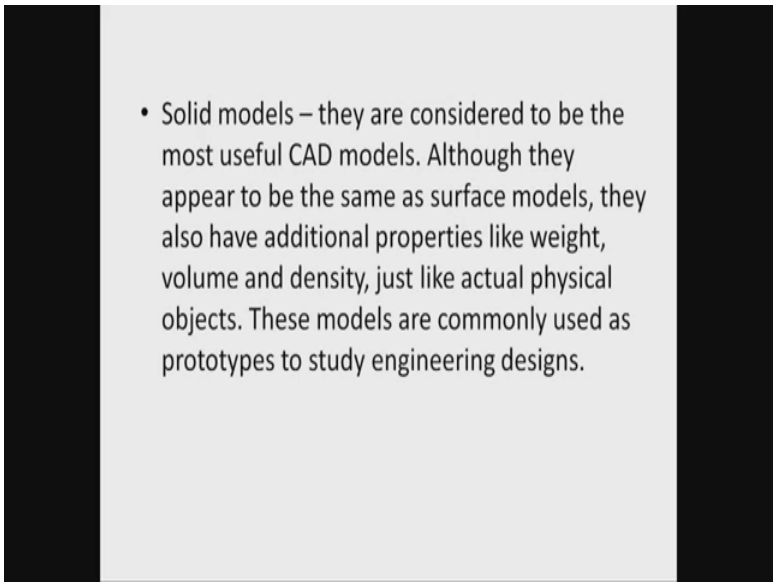

Let me pass this not about the thing, it only like to tell you; that it looks like a proper thing. Solid models are construct to be the most useful, they appear to be the same as surface except they have additional properties like weight, volume and density just like actual physical objects. See this is where you have the nice option of making prototypes which are really real; to the extent of some illustrator software take these things and make it what you call photo realistic renderings. And in some places, it is possible simplest when take talk about is may be if we have a rod and you have two weights; during calculation, we can optimize the design of the other points depending upon these weights and depending on the properties of the materials.

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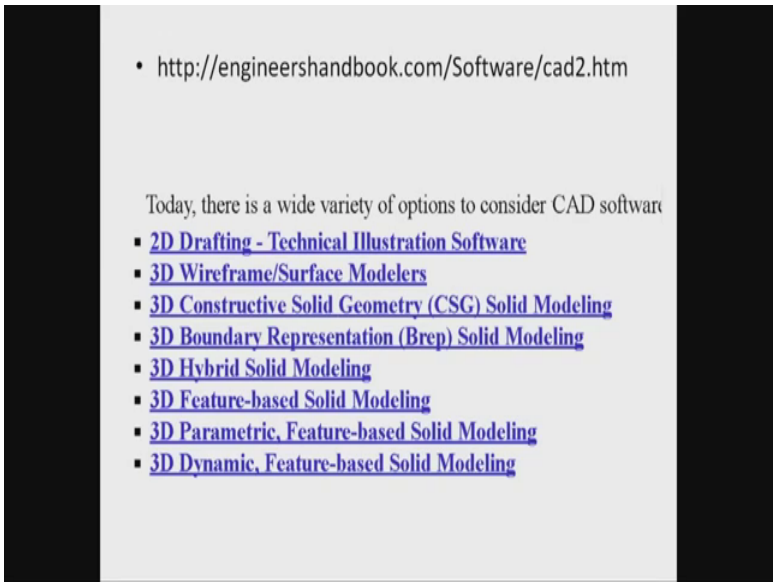

Again coming back to the earlier; you see here we have, from this engineers handbook beautiful things are there. We have simple 2D drafting technical illustration; you see here the word illustration is used, illustration is something which you write down and all that. Technical illustration talks about encoding whatever normally you do; this is what engineers continue to use.

So, several places in examinations and all; they will give you inclined plane. Inclined plane cannot be represented automatically in a 4 view drawing; I am sorry 3 view drawing. If you add a 4th view; that if is add a isometric or pictorial view, then inclined planes also can be handled. So, if you have a cube and one side is cut off; plan and then the elevated view looks still simple, the side view shows a slope.

I can create objects so it appear very complex in 3 views; if I take a, I mean what you call as a cube and then join some corners, make a triangular thing, attach something else on top of it and put in; it is still a technical illustration only a trained fabricator or a draftsmen will understand. Now, comeback to next level of this thing; we have the wire frame and surface modelers. Next slide is explain each of them then we have constructive solid geometry or solid modeling.

See wire frame surface modelers are still little like the wire frame only except that in the case of wire frame; the highlighted edges are shown. Surface modelers take those edges, join the edges and make them; while rendering or while presentation it makes it look like

a; all the features behind the surface are hidden. Say in the very elemental form, you just need three points in space; you have X 1, Y 1, Z 1; X 2, Y 2, Z 2; X 3, Y 3, Z 3 and then through an elemental space like this, a triangle can be drawn understand any three points in space and normally at flat triangle can be drawn.

Using this you can create complex surfaces; so, one of them is if I have two; I will put it here if I have two straight lines like this; in one plane, we can always join that edge and this edge and try to make a surface. Now, imagine it is twisted like that slightly; surface can be drawn in this immediately. So, what is done is the surface is slowly turned and make it to this; so the simplest way is take any point here, take any point here; make one triangle that is as if we have to have a flat sheet like this; here it is twisted.

In reality between any of these two vertices, we can make a fold you are seeing this; this is already a elemental triangle and a mesh with 4 vertices; where 2 of them have been join together to make a nice triangle. This is probably the starting point of all wire frame and surface model; that is depending on the resolution or granularity of the mesh, you can make things look as if they are real.

So, in reality this is a truly organic form, but in a representation of a CAD; you probably have one arc here; one more arc here and what is called some way of creating the surface will be there and all these; that is a beautiful depression here and it is in two colours. And then another thing which is very very easy to produce in CAD is; it has a non slip grip here, made with a different material.

So, maybe it is just a sticker maybe it is another material which is plugged inside. We have the various types of solid modeling including constructive, boundary representation hybrid, feature based solid modeling, parametric feature based and dynamic. When we talk about parametric, the essential thing is saying sequence of assembly; how two things are tied up together and bidirectional associative dimensions will be there.

Meaning, if we have a bearing housing and a circular bearing has to go inside; we can tie this to surfaces or you have a hole and then you have a screw or a plug can be inserted. We can tie this strings together and if we change something, dimensions will change and we can make the other thing also change. Alternatively, at the command form if you type the necessary dimensions; both of them will take the new except the feature (Refer Time: 26:35) thing as available and then I will try to explain to you here.

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So, each of them separately has been explained; again I said it is taken from the engineers handbook in the simple 2D drafting; specific options to look for when choosing a 2D drafting package. I am sure some of you have use the paint and word or compatible software which is available in most computers. I am what you call I have been given windows as such got use to it, but then I am sure MAC has better things and then I will not say better equally useful things and then so much is there in the Linux also.

Linux open software also it is there; in all of these, you still have 2D objects; all we have is, if we have two points you can have a line. And then if I have more points, you can put a very complex object and then something called handles and beta splines, busier curves and all that is a separate thing; anybody who is interested, I will show you a book by Zeid; z e i d.

You read the book; I could not read it because I sat in the class and I got it firsthand. So, we have stuffs about splines, polylines, ability to define hatching and all that. The actual technical 2D drafting packages have these features also; what is s a polyline, hatching, complex boundaries, associative hatching, complete dimensioning ability. So, sometimes we just need to pick any entity like a line and then automatically; it takes what are the necessary features and give you various things like simplest thing what we can talk about is a dimension and then something related is probably an angle and you can have a true

dimension of the actual entity and you can have the dimensions in all the orthogonal views; there is an advantage and there is a disadvantage; which as you start using, I am sure you will get it. The thing is some of the old free versions which were available did not have these developed well.

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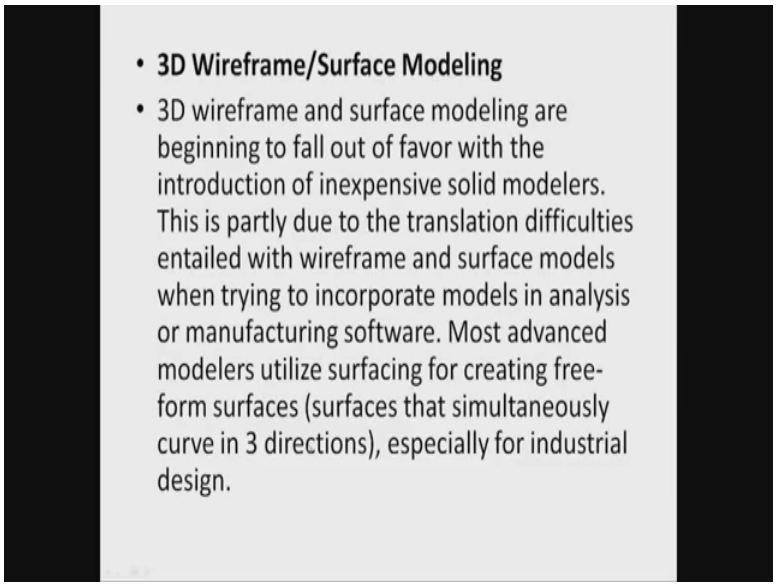

Eventually, we have got a materials; Bill Of Materials; BOD, now 3D wire face surface modeling which second one there, you see here; right now they are continued to be used, but they have been upgraded to the solid modelers due to the translation difficulties entitled with wire frame and surface models, trying to incorporate models in analysis or manufacturing software.

A surface modeler basically just shows you a surface, it does not talk too much about what is behind the surface or what the surface is about. Like I have told you what it; I am sure this can be easily done in clay; pat dove any cooky dove or anything and then let it dry up and then paint it and then also mask it and all that then you cannot make out in a normal this thing, whether it is solid or just a collection of surfaces.

So, that is the reason (Refer Time: 30:55) by simple surface modelers and these wire frame modelers have all grown up into genuine solid modelers. Advanced modelers utilize surfacing a for creative free form surfaces that simultaneously curve in 3 directions especially for industrial design. This course has been offered in industrial design, so at that point if you remember the second or third lecture; I showed you about

an ink pot.

Ink pot is just about an ink pot; I did not want to repeat it though have the samples here, but then it is attached with the timer and then has attached with a proper writing instrument and we have a new product. So, these things in industrial design especially this; what started of saying if you remember the first slide, we are talking about saying illustrating software is not so good for 2D because this has progressed so far and people are ready to pay for it. People pay good money, if you want a proper, software people pay good money and get these industrial design software.

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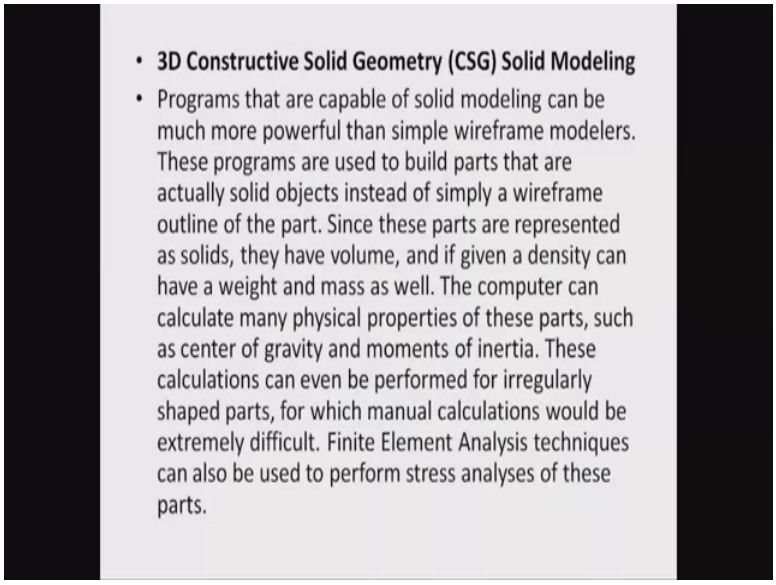

Solid modelers can be much more powerful than simple wire frame modelers. Actual solid objects instead of wire frame, since these parts are represented as solids have volume and given density have a weight and mass; computer can calculate many physical properties such as center of gravity and moments of inertia. Can even be performed for irregularly shaped parts for which manual calculation would be difficult. Finite element analysis techniques use to perform stress analysis.

So, constructive solid geometry is about the next thing; I mean will talk about it. Thing is saying, you actually make solids which have elements almost like the grains, which are distributed and based on that various things like density and things can be calculated which makes tremendous use in things like mould flow analysis. So, if you have a aluminum casting and then the way the mould flows inside, physical properties of rate of

cooling, rate of solidification, how a skin can is formed when it meets a cold surface, how the material actually flows inside; full models are available.

If you have the model and if you have the material and if you have physical process; you can find out how the actual physically the material flows inside and how the mould can be designed, how many can be optimized in a cavity and all these. This is where the constructive solid geometry made sense.