Design Practice - 2
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Lecture - 01
Design Concepts

Hello and welcome to this Design Practice 2 course, module 1. Quick introduction about me, I am Shantanu Bhattacharya, Professor at the Mechanical Engineering Department at IIT Kanpur and I also coordinate the design activity. This course is actually a part 2 for the course which was done previous and this is related to design practice 1 where we had learned about various concepts introductory to the design product design area.

We had also talked about the Stanford model of design thinking and various stages of you know engineering product designs as well as introduction to this technique of concurrent engineering through which all the different wings of an organization can participate together to formulate a certain outcome, a certain product and so there are very less scopes for a rework or you know redesigning the product because design is involved as a in synergism with the various wings which are associated with realizing the product.

We also talked extensively about product embodiment design, robustness of design, various techniques related to improving quality assurance behind product designs and later on production specifically we talked about failure mode effect analysis. We also did a lot of study related to the house of quality, how to trace the voice of the customer, the mind of the customer.

We talked about eximatic designing, we talked about a fundamental introduction to group technology where it could align a designer, particularly a engineering product designer to have minimum possible variance in a particular component or in a particular component at the subsystem level. We briefly mentioned about forms and shapes. In fact forms and shapes are very useful in representing any idea which could be in terms of a sketch which could actually be about how a product looks like, what is the aesthetics behind a product.

We also introduced some fundamental concepts of electronics and then finally ended up with lectures on material process, material selection for designers or even things related to the economics of work design etc. and then had a brief introduction into biomechanics. This is a part 2 module of the course which actually starts with concurrent designing philosophy which is involving how to use CAD tools okay.

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So we will actually like to do a lot of learning about how the backend data is processed so that what you see in the frontend as particular CAD shape or a size is realized and with in response to that we will study a lot of geometric transformations which are important to layout in terms of coordinate geometric terms any particular shape and size that is in question. We will talk extensively about 3-D shapes about solid modeling.

There is also some introduction to these very sunrise area of sensor systems which has just recently emerged maybe about a decade back which is also known as micro-electro mechanical systems. In context of that we will learn a little more about sensors and systems associated with sensors and then some of the actuators which are at different length scales. We will also talk about rapid prototyping as a technique, about 3-D printing.

Also associated rapid tooling, how you can develop processes related to the mold and how you can actually make a repeatable accurate process to realize the mold okay. We will also briefly

delve into embedded product or embedded designs particularly designing of embedded systems. We will go into a little bit of fundamentals in this course of you know elements related to the strength and stiffness of structural members, structural elements, particularly when they are assembled together as mechanisms and linkages.

So this will give you an idea of how you know you can integrate the mechanical part, partly with the electronic part so that you can make something which is an intelligent product okay. So the last part of the course will be dedicated to concepts of mechatronics, particularly introduction to control from the industrial perspective highlighting at several problems about how you know mechatronics can be successfully deploying in addressing things related to material handling, in addressing things related to automation within assembly lines or even at different workstations which could be pertaining to any industry.

So and then finally in intelligent product design we will probably have some cases and do some studies about what these products would be like with the learning that we have. So when we look at today's, so let us begin. So when we look at today's scenario of the industrial ecosystem which is prevalent around the country there is a very fundamental question that is raised which is about what is competitiveness influenced by okay or how can we see the change in dimension with respect to the, in respect to the competition between the various stakeholders which man this ecosystem.

And when we talk about such an expression and if we go back into the history and see how different parameters related to businesses have influenced the competitiveness. In the early 80s if we look at there was a huge emphasis or a huge shift towards what you used to call cost cutting or quality issues related to manufacturing of products.

So people who are really not used to customized designing and they were more adept to the mass production or concepts of mass production where they could not envision many variants to their taste or this likings and they had to be able to use only a very skewed set of product lines. Things changed quite rapidly and then starting from late 90s there has been this continuous function which has come as an invariable, inseparable component of industry which is called product

development okay or product design activity. And it has changed the dimensions of competiveness forever.

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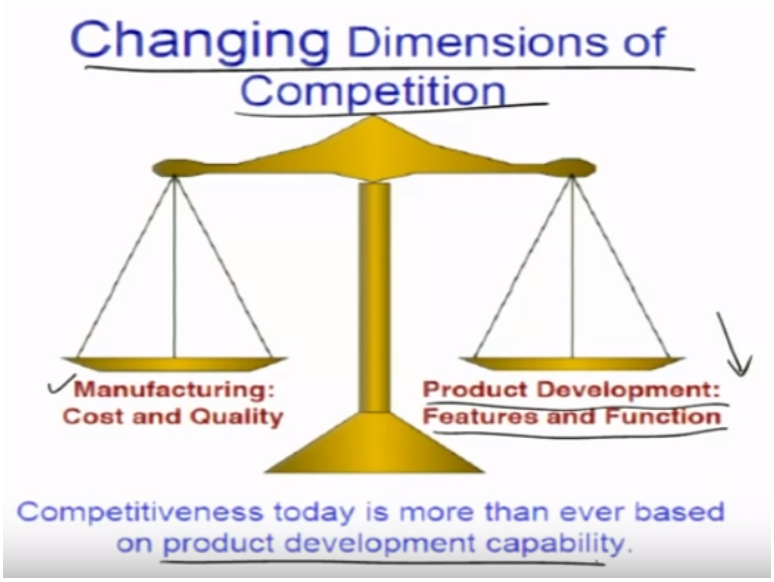

If I typically looked at this particular slide here which talks about such a change in the dimensions of competition obviously the side related to product development and product features or product functions have really started out things related to manufacturing cost or quality. So therefore it is very important to realize in the current business scenario if you want to survive how to improve your skills related to new product development, new product management, new service management systems which would give customers that one key element which is called customer delight okay.

And so therefore this course and in fact the earlier course was really specially designed for learnings related to such activities where you can do a lot of in thinking, a lot of customer mind mapping and trying to design things and essentially we are preparing you through these courses with the various tools which are there to understand about the customer psyche and to route that into different products. So let us look at products and what are really these products.

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So I could very carefully define product to be a set of attributes offered to consumers and these attributes fulfill their needs or requirements which make them high in demand when we talk about marketing such attributes within customers. So essentially product is nothing but a vehicle which will help providing the required benefit to its users and obviously the final goal that a product would have is in terms of customer satisfaction.

So a lot of customer psyche has to be captured within the product so that this satisfaction can outrightly come up. And obviously as one may recall that utility that a product gives in terms of not only the functional aspect of the product but also the overall aesthetics, shape, size and also the way that the product creates a niche within the customer psyche or the customer's mind is very important for the product.

So the benefits of such consumer oriented products and marketing of such products are that it definitely makes you go ahead in the business multiple folds because you are actually being able to satisfy the customer more. It is an organized way of how to satisfy, how to influence the customer more and then obviously you can achieve organizational objectives of success, growth, benefits if you could sell your products well. So that is in a nutshell what I would like to say about products.

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Let us look at some product lines and this is very famous sort of slide borrowed from one of the text books by Ulrich about product design. So here when we talk about a variety of such products as you see there can be a screwdriver. This is a desk jet printer, then Boeing 737 airplane, Volkswagen Beetle and then Rollerblade skates.

And if I looked at each of these products and if we think about what their functionality aspects are the products kind of range from the simplest of the products which is a screwdriver to the most complex product which is an airplane. But the process of thinking that has gone into each of these products or the process of mapping that to the customer psyche which has gone into these products are exactly similar to each other.

The only difference is in terms of the technology which has been assembled together to put together things in terms of the spans of time or length scales, the amount of investment that has made to design this different products over at different times, different time scales. So in a nutshell although the processes of product designs are kind of similar to each other there is a lot of variant in terms of the length scales you know sorry the time scales across which development activities take place.

Or the different external stakeholders who are involved in this products versus the internal stakeholders, the design and development times, the amount of costs that is involved in product

designing or the amount of cost that is involved in managing the whole lifecycle behind a certain product.

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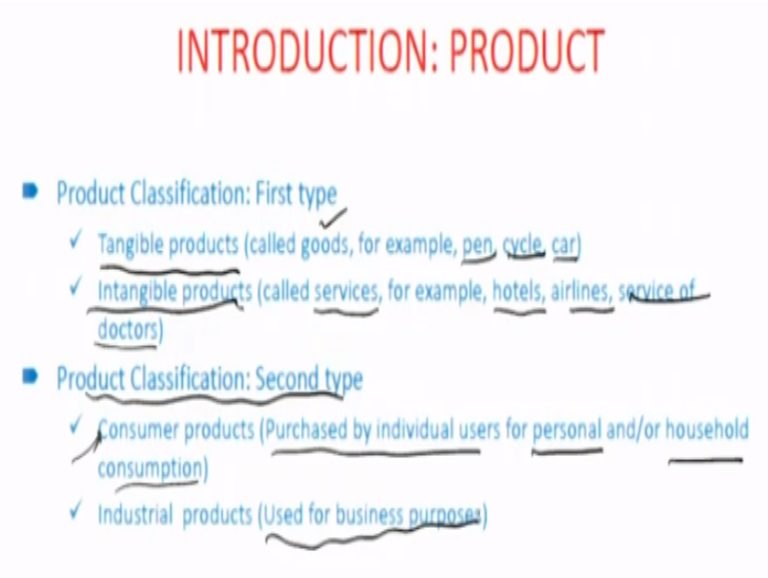

So if I looked at some classifications of all these different products there can be one kind of product which are actually tangible products okay and these tangible products may include some of the products that you saw in the earlier slide for example that could be a car or let us say a bicycle or a pen or any goods which are actually things that you can feel and touch and use and see what their functionality is they are more direct to deliver their utility as a vehicle to the particular customer and so that is what is called a tangible product.

There can also be intangible products where either you cannot really touch and feel those products but it does deliver satisfaction to your mind or which could be in terms of let us say services. Services being offered at hotels, at airlines, you know services of a doctor which are so important and they can also be grouped as sort of products which are intangible and therefore each of these whether it is intangible or a tangible product calls for giving satisfaction in a way that it is intended to the particular customer who is mind.

So there is yet another kind of classification that products may have. So there can be products which are purchased by individual users and products which can be deployed directly for personal or household uses or consumption. So these kind of products are known as consumer

products and then of course there are products like for example a Gantry chain or a let us say an industrial crane or an assembly line which is related to use within some industry which produces goods at a certain rate, industry which is purely for any business purpose associated with that industrial unit and such products are known as industrial products. So that is what in a nutshell the various forms of product classifications can be put together as.

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There are many beautiful looking products for example some of these apple products which change to the way that people used to think. For example this small laptop okay, a Mac is in terms of its weight, in terms of its carriability, in terms of its usage, satisfies many needs which were not there earlier prior to introduction of this particular product or this ipod which talks about can you have your own customized music library outside a musical store okay and carry it in your pocket.

So these kind of wonderful ideas of thoughts have been put together and has it has been demonstrated by various companies that such kind of innovative simply better products do exist and it finds its way into the market penetrates deep into the market and actually can be considered to be deceptive technology and time.

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Then some other products which I can easily refer to which talks about how you know use can be customer use can be mapped in terms of shapes and sizes, in terms of tangible goods that can create value within markets. This example of Black & Decker snake light, it is flexible neck and powerful light which is rechargeable okay. This snake like orientation of the particular light allows it to go into very small gaps.

Particularly useful in auto wheel repair when you are talking about hitting the engine room and doing some repair related to an underbody or an engine room problem. You do need elimination at nooks and corners where otherwise lamps cannot get into. It provides features like LEDs, powerful battery packs particularly lithium iron batteries which are very long lasting.

Creates ultra-bright conditions for a longer time and helps in positioning rapidly within such nooks and crevices. So this is again a sort of customer psyche mapped into what could have been otherwise an ordinary bulb invented by Thomas Alva Edison. So that is what design makes to the basic fundamental need which does exist. It makes it look much better and it makes it much more useable and it generates lot of satisfaction of the user who is involved in using.

So another interesting example is this GoodGrips angled measuring cups. If you look at this cup say it has a patented design of reading from the top. So in a top down manner you can read the meniscus and the meniscus levels which otherwise would mean a conventional measuring

cylinder where the concerned user has to go down to the level of the meniscus to see exactly where the position of the meniscus is with respect to a vertical airline scale.

So the very fact of angling that particular scale or putting the scale in a certain angle helps you to do the exact same thing without bending and going to the level of the meniscus and it is just, it can be done top down okay. The cup has several other features like a very good grip which is provided by this well designed handle. Of course the scale can also measure ounce and millimeter markings. So there are two different grades in terms of different units.

Of course it also needs, it also eliminates the need to fill, check and adjust because everything that you are able to visualize from the top is what actually turns out to be the level of the fluid which is inside. So again customer psyche mapped into the ordinary measuring cylinder. Another example could be this very famous target prescription pill bottle which has several different advantages over a conventional bottle.

It has the name of the doctor mentioned, the contact id of the doctor mentioned. There is a colored portion of the bottle which indicates who is the concerned person in the family who will have these medications. You can color code different patients, okay. The patient info also is mentioned in the particular bottle and what is the drug exactly and what is the dosage you know is also mentioned.

There are many instances where customers who are regular users of different pills forget about if they are consuming multiple pills, forget about their exact dosage in a particular pill and they have to refer back to the prescription again and again. So all this goes into the bottle itself which makes it much more useable. So again how much of that psyche can you really put into your product to make you number one in the market is all about how product development or design activities can be carried out.

And so if I think about this if I looked into some of these different products one important aspect is that how do you initiate them from a very fundamental design in terms of a sketch which

would attract attention okay. And when we talk about such sketches, we deal with two different aspects of such sketches which are very well known and they are shapes and forms, okay.

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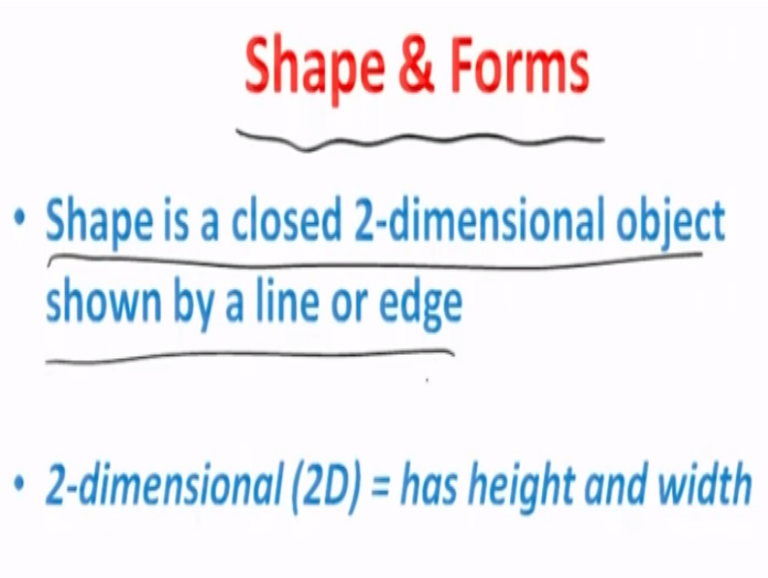

And so today in this particular lecture I would like to just delve a little bit into this shapes and forms concept and probably in the next lecture we will talk about how to make such shapes and forms into different 2-D and 3-D shapes, particularly aligned with the power of a computational tool. So obviously a shape is a closed 2-dimensional object okay. It can be showed by an edge or a line 2-dimensional object for example could have either height or width or it could have length and width or it could also have length and height okay.

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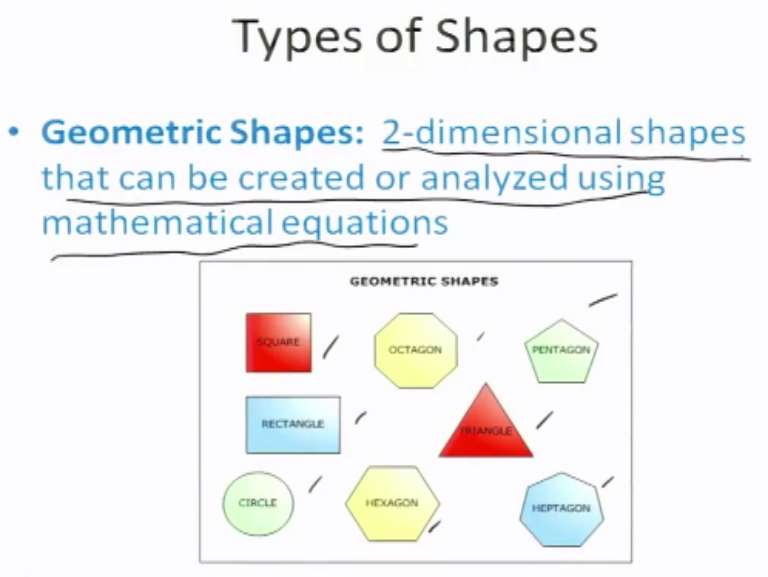

And so these are some different geometric shapes. They can be a square, pentagon, octagon, triangle, heptagon, hexagon, circle, rectangle based on how many sides and what are the relative dimensions of sides with respect to each other that can be. So the 2-dimensional shapes can be created or analyzed using fundamental mathematical equations okay.

And so one of the aspects of how to create these shapes and space would be about laying them out in a x, y, x coordinate and trying to map them and then when we change positions or rotate them or translate them or let us say do various manipulations to them, how the coordinates would suitably change. So one of the principle ways of looking at these forms and shapes when we talk about computer systems.

In fact today a product design is inseparable from the tools of the current century, the high speed computational tools of the current century and so therefore the product design has to be taught in line with computer assisted or computer aided product design. But what goes into the backend of such tools is typically something that one has to you know do a detailed study of and so what we are going to come next is into how to develop such shapes using different equations and trying to solve those to see how the shapes do orient and so the frontend as well as backend will be in parallel continued okay for this particular study.

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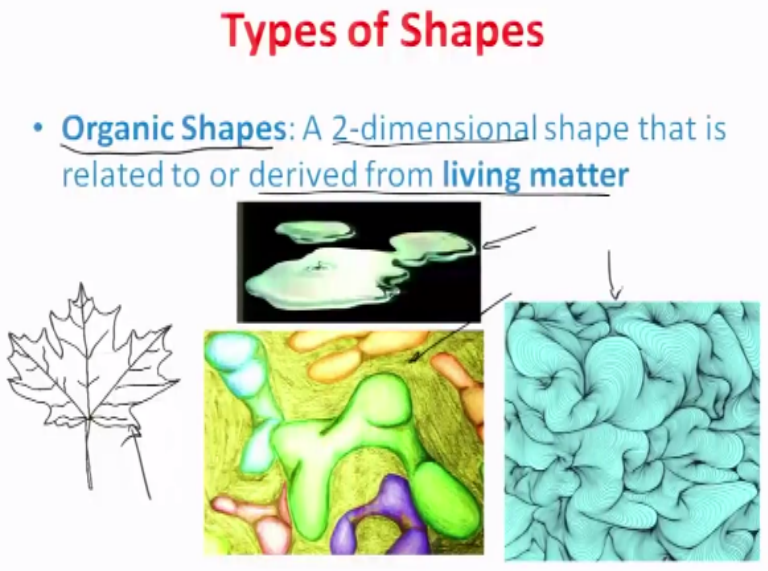

There are also different shapes which are mostly derived from living matters. They are not so regular as you saw in the last step and typically also known as organic shapes where you can for instance look at a particular leaf in 2-dimension or these different forms of sketches you know which has come up from different you know naturally influenced objects particularly living matter. And so a lot of these aspects can be trapped within such organic shapes.

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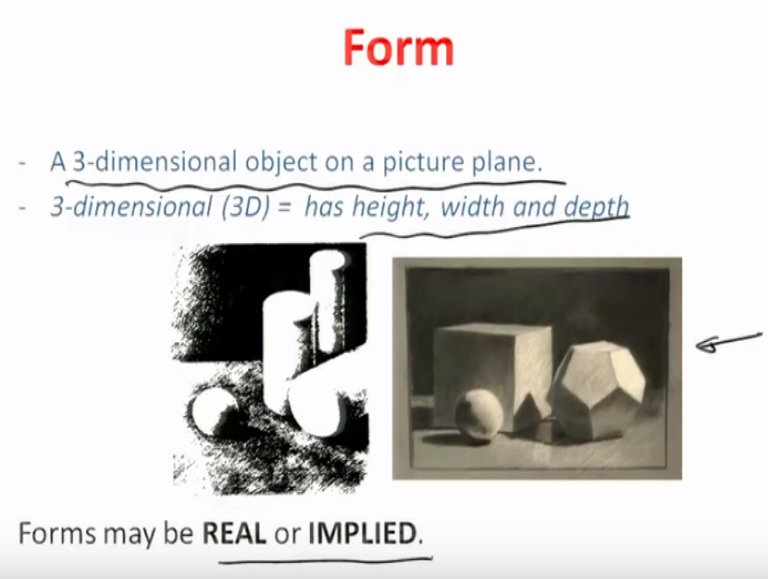

The other important of aspect is a form which is about you know a 3-dimensional object and how to represent this on a picture plane okay. So typically this would have height, it would have width and also depth. So this for example you know is a representation in a 2-D but actually it looks like a 3-D shape. So this is what is meant by how to represent a form, a 3-D in a 2-D plane. Forms may be further real or implied forms.

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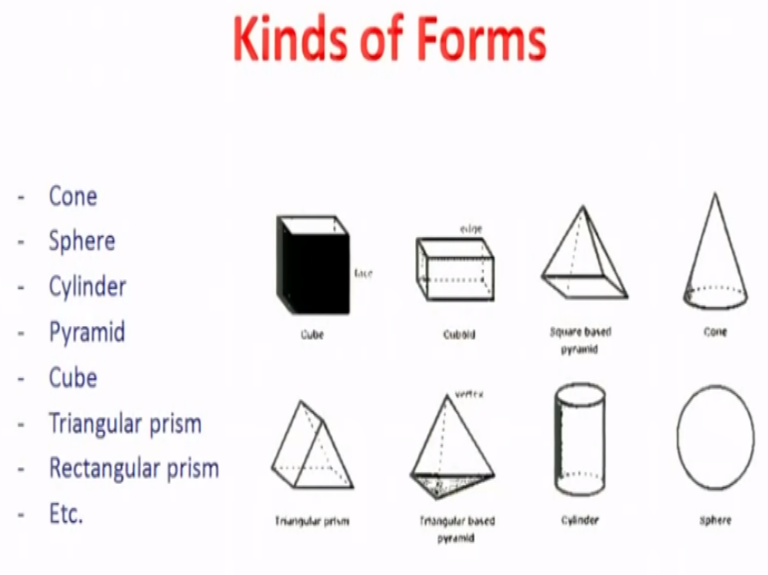

And there are different ways and means of representing regular forms which are in terms of regular architectures like cones, spheres, cylinder, pyramid, cube, triangular prism, rectangular prism so on so forth. A variety of these forms can be seen here.

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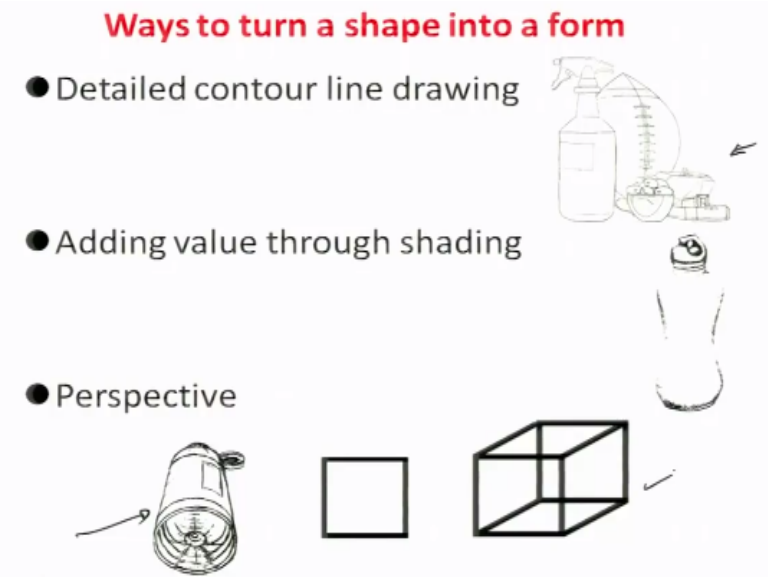

So when we talk about representing regular forms just as we did in the case of organic shapes and also when we represent you know a shape to be converted into a form we could do that by a variety of methods particularly you could have a detailed contour line drawing as illustrated here. You could also talk about adding value through shading. This is another example of how shading can help in representing or visualizing a 3-D form out of in a particular 2-D plane, okay.

You could also talk about the perspective which is the art of representing again 3-dimensional objects on a 2-dimensional surface so as to give the right impression of their height, width, depth. This for example is a perspective drawing of a water bottle or again you know if I looked at the regular shape, a square could have a perspective drawing which is in terms of a sort of a cuboid. So this is how different shapes can be, 2-D shapes can be turned into different forms.

So with this I would like to sort of end today's lecture by giving you an idea of how important it is to express different products in terms of their aesthetic design or their layout and the next step that we will emerge in probably the next lecture is how to take some of the shapes and forms in the real CAD of the computer assisted designing and trying to plot them on 2-D screen using coordinate transmissions. So till then thank you very much for listening to me. Thank you.