Engineering/Architectural Graphics – Part 1 Orthographic Projection

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Lecture – 11
Introduction to Orthographic Projection

Good morning. Welcome to this 3rd week of ongoing course on architectural graphics or engineering graphics where we are discussing about orthographic projections. So, I am your instructor Dr. Avlokita and from this week onwards we are going to understand about orthographic projections. In the past two weeks, we have dealt with the basic geometrical constructions and all the fundamentals which we will require now.

So, before I go on to discuss in detail about what orthographic projection is and how do we do it? We should first understand what is a projection and why at all a projection is needed? So, why at all do we need a projection? Most of the time the works that engineers and architectures do is to visualize, to design a 3D object. It could be an object, it could be a furniture, it could be a building, a huge structure like a dam or anything.

But we visualize, we design it in our heads first. We visualize, conceptualize that idea and then that idea has to be drawn on the sheet of paper so that it can be communicated to everyone. Now it is not just about communicating the idea that okay the building that I am envisaging looks like a sphere no, it is also about communicating what would be the dimension.

So, if there are multiple solids coming together then how those solids are intersecting with each other. What are the dimensions, how are they placed, at what angle are they placed all that is required to be communicated in such a manner that there is no ambiguity in communicating your ideas, this is what we have already learned about the language of graphics which is exactly what we are going to do, execute through these projections.

So, what we are basically doing is we are representing these 3D objects or buildings or structures on to a 2D sheet of paper with the help of projections. So, that is the reason why

we need projections. Now what is a projection? So, when we have a 3D object, for example, a cube like this. Now, how do I draw a 3D object like this cube on to a plane sheet of paper? So, what I can do possibly is I can say how does this cube look from the top.

What are its dimensions? So I know that. What view would be seen if I look at this cube from the side or from the front what would be drawn. Now how do we know that this is what we are seeing from top is with the help of these projections. So, what we assume is that there is a light source coming from top or side or front and the rays of light which are projecting this surface on to a screen, on to a projection surface, this entire thing is called projection.

So, what we do we actually project with the help of a light source and the rays which are cutting, which are being intercepted by this surface, any surface before it gets projected on to the screen is what is called a projection. Now projections could be multiple types. So, we could assume that the light source is here, we could assume that the light sources is right on top of it.

We could assume the light source is here, it could be anyways and depending on this light source and the kind of rays which are coming falling on to the object the various types of projections are defined. We are here concerned about orthographic projections. So, what is orthographic projection? When we assume that the light source from which the light rays are coming is directly perpendicular to the surface, to the object not rather to the object, but to the projection plane.

I will come to the projection plane and the rays which are coming from the light source are all parallel to each other and they are perpendicular to the projection surface where the shadow of this or the rays from intercepting this object are being projected. When these rays are parallel to each other and perpendicular to this projection surface that is when we call it an orthographic projection. Now what is the advantage of taking all these rays parallel to each other?

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If we have a ray which are parallel so what will happen the actual distance of this object if the rays are hitting perpendicular to the surface, the distance between the rays remains the same because they are parallel. So, the ray which is hitting this surface and the ray which is hitting this surface since they are parallel, so even when they are projected on to the screen straight the distance between these two rays which is actually the size of the object remains the same.

So, it makes our job easier. We can write the dimensions while projecting this object. So, that is why we most preferably, most often we use this orthographic projection. Now, it is not necessary that the object be kept perpendicular in a simple position it could be like this. So, then there are multiple ways of projecting, but we would still go with orthographic projection in this case suppose the cube is resting on one of its vertices like this.

And if the rays are assumed to be coming parallel and perpendicular to this projection plane in that case we would not be seeing the true shape, but what we will be seeing is the true angle probably in one of the views. So, we would know that what is the angle and if we rotate the projection plane or if we rotate the cube by certain degree we might be able to see the true shape and size of the cube. So, that is what is possible with the help of orthographic projection.

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Now as important as is the object and how light is falling on to it equally important is this projection plane. So, there are two planes actually which we consider. So, we actually have two planes which intersect together. One is a vertical plane which we often represent as VP. So, either we call it a vertical plane or a frontal plane because if I place it like this so this is the horizontal plane the HP.

And this is the vertical plane or frontal plane because we assume that if the object is placed in front of these planes then this plane where the front is being projected is the frontal plane and the plane where the top is being projected is the horizontal plane that is the same nomenclature which we use when we draw the projections, orthographic projections on the sheet.

Now, this is a vertical plane VP or a frontal plane FP and this is a horizontal plane and the line where these planes intersect is called as a reference line and this line we often represent as X Y. So, we draw either above it or below it very rarely would you see that we draw on it. It is in very rare cases that we draw on the reference line because no object often we consider to be intersecting these two planes on the reference line.

So, this is the reference line, this is the frontal plane, the vertical plane and the horizontal plane. Now what I have explained to you so far is assuming that the plane is only up till here and this horizontal plane is up till here, but in actual these plane they extend beyond this

reference line as well. So, the horizontal plane extends towards the back and the vertical plane extends below the horizontal plane as well.

So, it remains the same. The vertical plane continuously remains the vertical plane and the horizontal plane will remain the horizontal plane the quadrants there are multiple quadrants that this arrangement creates. So, we have the first quadrants, the second quadrant at the back of it, the third quadrant which is diagonally opposite and the fourth quadrant here. We will come to how the objects will be seen or how they will be projected their projections be drawn later in the next lecture.

But what w have to understand here is how do we actually visualize or how will we draw? So, when we are drawing this entire system of plane will be assume to be folded like this. So, if I fold this like this so horizontal plane goes to the bottom and the back of the horizontal plane, the extended part of the horizontal plane comes and merges here. So, when you draw your sheet you will actually be seeing a reference line here which is the intersection of these two planes.

We will be seeing an elevation or a front view here in the frontal plane or vertical plane and we will be seeing something which will be drawn on to this horizontal plane here. So, if I have suppose I had this cube so just imagine that this cube is placed in a very simple position such that its face is parallel to the VP and its bottom face is parallel to the HP it might be kept in HP or it might be raised and kept like that.

Now if I look at it from top what will I see? I will see a square and if I see it from the front then I will see a square as well. If I just fold it like this what will I see? I will see a square here and I will see a square here. Now one thing which we have to keep in mind is that the projection lines for these should always merge because if you look at this I will unfold it again.

And if you look at this what are we doing? We are drawing a projection line which is straight like this and we are drawing a projection line which is straight like this. Now assume though we are going to be drawing I will roughly draw a square here it is the simplest of the shape

that we can assume and there is a line which is straight like this. So, if I unfold it if I remove it so then we will have a square and assuming that this line was going like this there will be a straight line which will be taken up.

And in the same direction if you again see what were we seeing? There are actually multiple rays, multiple light rays which are seen. So, a light ray which is intercepted by the top surface like this and there are light rays which are intercepted by the bottom surface. So, what we would have is we will have light rays going continuously parallel and we will see another square which is absolutely in alignment with this that is the fundamental principle of orthographic projection.

Since the light rays are parallel always they will remain parallel. Now, there could be one more plane rather two planes. We could have another plane here. So, if the cube was placed here now cube is simple to understand because all its faces if they are perpendicular or parallel to the projection surface then they will be seen as squares. So, just assume that we have another surface here projection surface here.

So, what we would see from the side view? This is front, this is top and this is the side view is again a square, but the light rays will again merge. So, what we are seeing there is a light ray which is parallel to the surface and also another ones which are parallel to this surface. So, what we will have? The top surface of the cube in elevation will match with the top surface, top line of the cube inside elevation.

So, as I use these terminologies I should explain it here. Anything that we see projected on the vertical plane, the frontal plane is front view or front elevation. If we are seeing it from the side then it is a side elevation. Which side are you seeing it? So, this is the object and I see it from the right hand side. So, I will see the right hand side elevation projected on to the left side assume this is the flap opening on to that side.

If I see it from the left hand side we will have a left hand side drawn on to the right hand side, but before that what we see from the top is the top view or we commonly know it as plan. So, we have front elevation, we have side elevations and we have a plan and most often than not

these four together should be able to give you the true dimensions of the object and a comprehensive idea of what this object will look like.

In some cases when we are not able to decipher the real shape of the object with the help of this front view, side views, side elevations and plan in that case we will draw the section of the object. So, from outside this might look like a solid cube, what is inside? So, suppose there is a hollow sphere inside it and if I want to show it then in that case we will use hidden lines as well.

And we can also show a section that okay if I cut open this cube. So I will use a section plane and I will show that what is inside this so that is also needed sometimes. We need sections to show the inside of the solids, inside of the objects. So, this is what we need to know, we need to understand when we are starting with orthographic projections. Now, there are certain simple shapes with which we can start to understand the orthographic projections.

I will just give you a brief idea of how do we take these objects forward. I have very conveniently explained to you how the cube looks like which is the most simple. If it is a cuboids maybe elongated like this then we would see rectangular surfaces almost all the surfaces will go to become rectangular, sphere is easy again. So, what we see in a sphere is when we project it from the top then we see a circle.

So, it is simple. We would see a circle suppose we have a cone now what would the cone look like depends upon from where are we viewing it.

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So, for example if we have this quadrant like this, if the cone is placed in horizontal plane like this then what will you see? You will see a circle from the top in the plan you will actually be seeing just a plane circle, but in front elevation we would be seeing a triangle. Now if the cone was placed perpendicular to this frontal plane this vertical plane in that case in elevation we would actually be seeing a circle flat circle.

As I am moving this with the help of this light probably you can see the shadow as they are being cast. So we have a circle in front plane, the vertical plane and we would see a triangle here. Now, what happens if we keep the cone in horizontal plane on one of its generators. This is one of its generators.

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So, if I keep the cone like this what would you see in the plan? Now, if you look at this, this is a simple cone what we would see? We would see a part of the base which would actually appear as an ellipse and we would again see a triangle at tangent where the tangents are emerging from the ellipse. So, this is what we are going to see. Now, with the help of these various pictures, these various views we can actually calculate the real dimensions of the objects and we can reproduce them, we can construct them again.

This is the intent. Now in the next lecture what we are going to understand is what is the difference between these different projection systems and how do we use them. In India, for almost all purposes we use the first quadrant. In first quadrants always, you will have the plan in the bottom and the front elevation and side elevations in the top above the reference line. While for different other quadrants, we will have a different nomenclature.

In other countries different nomenclatures are followed, but in India we use a first quadrant system which is what we are going to understand in the upcoming lectures. So, I hope you have understood the basics of this orthographic projection and we would start with the difference between first quadrant and third quadrant projections which are the two most commonly used quadrants in the next lecture. So, thank you for being with me here today. See you again in the next lecture. Thank you.