

## Research Article

# Projecting Perspectives

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Creating a drawing which communicates a vision, and feeling, of a particular design is an important objective for an architect and engineer. Perspective drawing is considered one of the most valuable tools for communicating a design vision. While many methods have developed over time, the sequential process of the conventional perspective remains the same; to first begin with a completed floor plan, and then orthographically project the parts from the plan into a view of a one-, two-, or three-point perspective drawing. The resulting perspective view graphically presents “what” a space or building feels like based on the parts from a plan. In contrast, this paper explores the possibility of reversing the sequence of the conventional perspective methods seeking instead the question of “why” a view has feeling by projecting a measurable floor plan directly from within a perspective view.

## 1. Introduction

The nature of engineering and architectural design is to solve problems, and through problem solving, as designers we have various available drawing tools; such as plans, sections, elevations, axonometric, and perspective drawing. The goal of the problem solving process is to use the various drawings types to communicate the essence of an idea and vision to others. Perspective drawing is one of the most insightful drawing tools available in communicating a design vision.

While there have been many perspective methods which have developed over time, the basic sequential process of the conventional perspective remains the same; to start first with a detailed plan which is used to orthographically project the parts from the plan into a view of a one-, two-, or three-point perspective. The resulting perspective scene graphically

presents “what” a space or building feels like based on the parts from the plan. The problem with the conventional approach is that a refined plan is needed first, predetermines certain aspects of space arrangements prior to fully understanding what the space feels like.

In contrast to the conventional method, this paper explores the possibility of reversing the sequence of the conventional perspective, in order to seek a process which graphically explores the question of “why” a perspective view has feeling by projecting a plan from within the perspective view.

## **2. Reversing the Sequence of the Conventional Perspective**

In analytical research, reverse engineering is a unique methodology. It is used primarily to take apart and recreate a device or system. In some fields of study, reverse engineering is viewed as the inverse to creating [1]. In other fields such as photogrammetry, descriptive geometry is used to formulate a method which locates vanishing points and elements from within a photograph [2]. In this paper, we are seeking an approach that uses reverse engineering as a tool for the creative process of design. By providing sequential steps, a manual method, may allow for opportunities for the mind’s intuition to adapt during each stage of the reverse engineering process.

Understanding the geometric framework of the conventional perspective method is not a prerequisite for using the REP method. But the basic concept of the conventional perspective must be understood in order to know how the REP works. In a simplified notion, the conventional perspective has three basic sequential steps in order to construct a scene; first start with a floor plan, then determine the station point or the axis of view, and last finding the vanishing points according to the angles the plan view is making with the picture plane. There are of course critical sub steps which this paper will not go into detail, but further research is encouraged [3]. The reversing of this order; determine the viewer position, locate the vanishing points, and the last step is constructing a plan view. The critical part of the REP method then is to first begin with a perspective drawing, which can be either naturally free hand sketched perspective or drawn with a more refined precision.

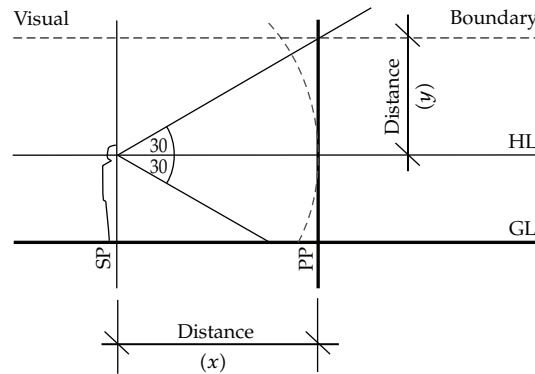
## **3. Naturally Drawn Perspective**

For the sake of clarity, our selected perspective for this paper is a naturally drawn perspective with a blend of both loose sketched lines combined with a refined technique. The drawing used to exemplify this REP method was taken out of a travel sketchbook from Bologna Italy. This perspective scene describes forms, shapes, and light quality as seen directly from the place (Figure 2). The REP method in the following section details the steps on how to pull a project a plan directly from this perspective hand drawing.

## **4. The Reverse Engineered Perspective Method (REP)**

### ***4.1. Locating the Observer: Finding Constants within the Natural Perspective***

The initial steps in applying the Reverse Engineered Perspective method (REP) is to first analyze and study the inherent geometries within the natural perspective sketch. This first



**Figure 1:** Visual angle diagram.

step begins with the location of the observer and the following elements: locating the horizon line, ground line, and determining the boundaries within the sketch.

Locating the observers in this natural perspective (Figure 2) is as follows:

*Step 1.* Locate the Horizon Line (HL); within the natural perspective drawing. The horizon line is a “virtual line” at eye level of the observer which identifies where the ground and sky come together.

*Step 2.* Establish the Ground Line (GL)-based on the HL this line determines the height of the viewer. Locate this line based on the elements drawn in the sketch, such as people, benches, tress.

*Step 3.* Locate the True Height Line (THL); this is a measurable line usually located at the edge of the perimeter of the drawing (Figure 3).

*Step 4.* Setting the picture plane (PP); in order to find the PP one must determine the distance ( $x$ ) between the observer (also known as the Station Point) and the picture plane. In order to solve for ( $x$ ), we will use a maximum allowable sight, or cone of vision, that the human eye can see (Figures 1 and 4). It has been determined that this falls within 30 degrees above and below the horizontal line of sight, forming a total cone of 60 degrees [4].

By using a 1.68 m scale factor, which is the average line of sight line of a human being, we can establish ( $y$ ) by measuring in 1.68 m increments, starting from the HL to the top of the vertical boundary of the drawing, this gives an the approximate distance  $y = (2.14)$ . Solving for ( $x$ ) we use  $\tan \theta = 30$ . The distance between the station point and the picture plan is now obtained (Figures 1, 3, and 4)

$$\tan \theta = \frac{\text{distance } (y)}{\text{distance } (x)}, \quad \text{distance } (x) = \frac{\text{distance } (y)}{\tan \theta}, \quad (4.1)$$

$$\text{distance } (y) = 2.14 \text{ m}, \quad \theta = 30^\circ.$$



Figure 2: Natural perspective drawing: Bologna Colonnade (Bologna, Italy).

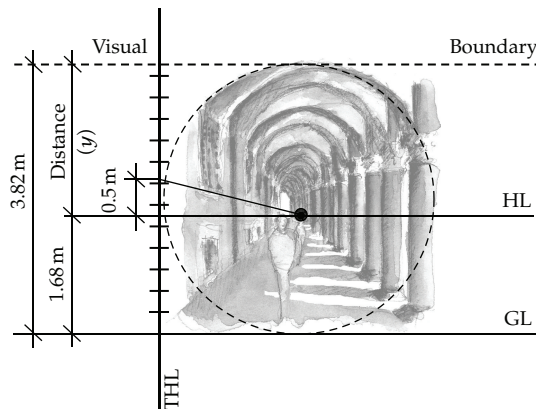


Figure 3: REP visual boundary.

Therefore,

$$\text{distance } (x) = \frac{2.14 \text{ m}}{\tan 30^\circ}, \quad (4.2)$$

$$\text{distance } (x) = 3.71 \text{ m}.$$

*Step 5.* Draw the Picture Plane line above the perspective; now from the Station point (SP) measure vertically  $x = (3.71 \text{ m})$ . A horizontal line designates the PP.

*Step 6.* Locating vanishing points (VP) on the HL by extending lines from the object drawn in the natural perspective. Extend the VP from the HL to the PP; by connecting these point back to the SP this now gives you the true angle; the perpendicular angles used to draw the plan (Figure 5).

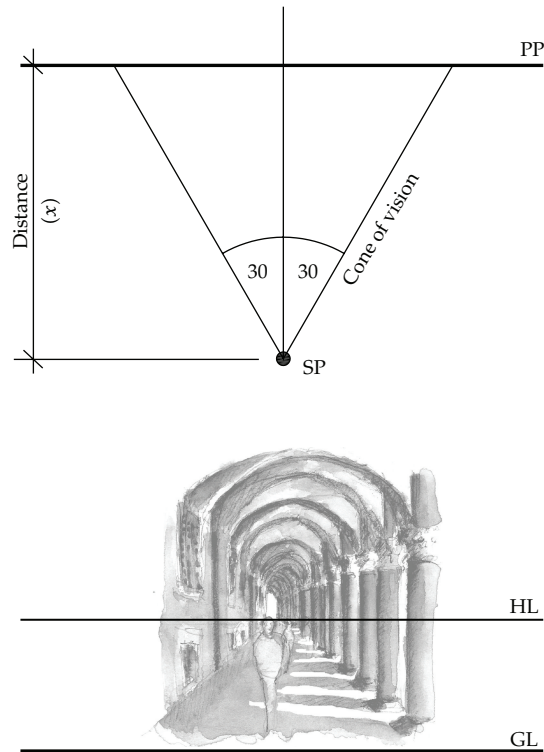


Figure 4: REP picture plane.

#### 4.2. Locating Vanishing Points: Describing the Overall Form in Plan Geometries

With the determination of the location of the observer SP, and the picture plane, the next series of steps are used to draw the overall form in plan. This perspective has two identified vanishing points (Figure 5). With the distance from the SP of (3.71 m) from the PP we can properly trace this geometry back to the SP to find the angles of the plan.

*Step 7.* Locate the true angles; extend the VP points from the HL up orthographically into the PP, then connect the VP from the PP back to the SP. The bold lines illustrated in (Figure 5) are the true angles which will be used to construct the plan.

*Step 8.* True angle projections; measurable lengths of lines in perspective view are found by means of true angle plan projections. First in perspective view, the start and end points of a line are located and orthographically drawn up to the PP. By connecting these points back to the SP, and projecting outward from the PP, angles are created which are use to determine the start and end points for the true angle projections (Figures 6 and 7).

Looking closely at the colonnade in this natural perspective (Figure 2), one can see there is a slight bend in the distance. The REP method has identified this “bend” as having two vanishing points. In plan, the angled pathway immerges when connecting two points along VP2 (Figure 7).

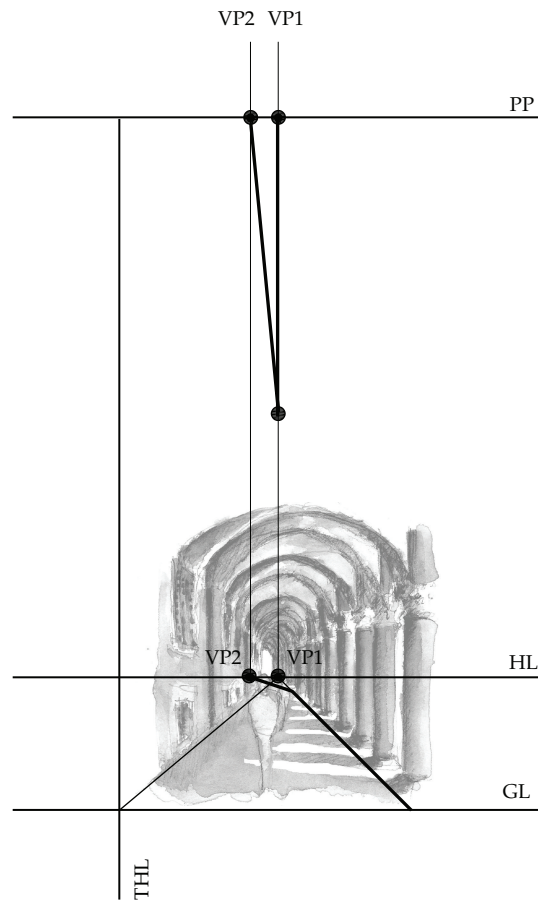


Figure 5: REP locating vanishing points.

#### **4.3. Constructing a Floor Plan: Locating the Parts within the Geometrical Form**

Thus far in plan, the overall form has been determined by the vanishing points within the perspective and distance from the view to the picture plane. The next series of REP steps illustrates how to locate the parts within the overall form. For any sketch there are a hierarchy of parts which makes up the whole. Articulating the relationship between major and minor elements with construction lines will help to unfold a plan with ease.

The “parts” in this sketch which fill in the form; the colonnades, the windows, and the pilaster bump outs from the wall to the left of the perspective view. Secondary elements which can be described in two dimensions, are the arches which connect the colonnade with the pilasters. The following REP steps are as followed to located parts within the natural perspective.

*Step 9.* Along the one of VP lines in the perspective sketch, locate an edge of one of the elements with a vertical line. As this line is extended to the PP, a connecting angle from the SP to the line in plan will located the element in plan (Figure 8).

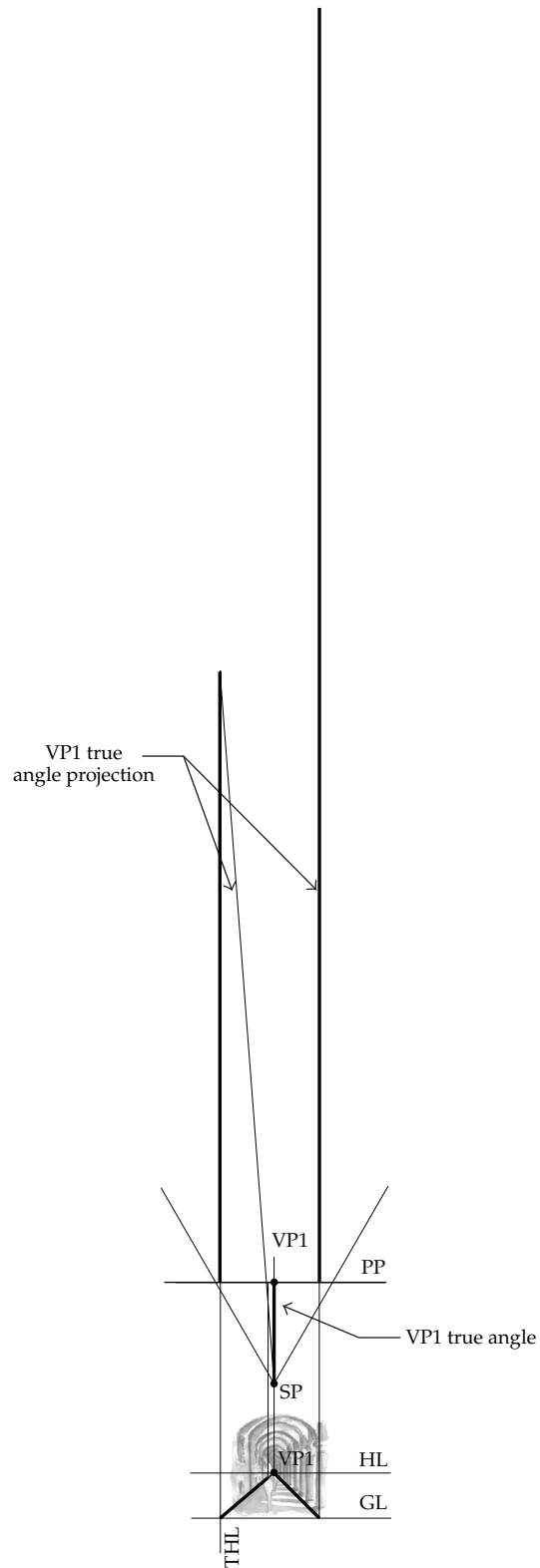


Figure 6: REP projecting vanishing point 1.

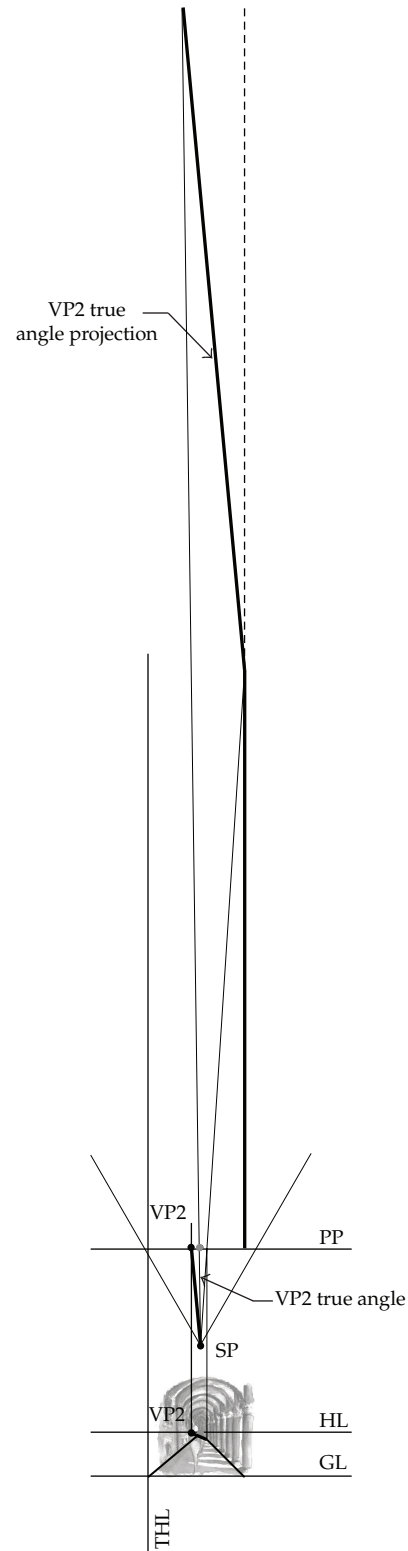


Figure 7: REP projecting vanishing point 2.



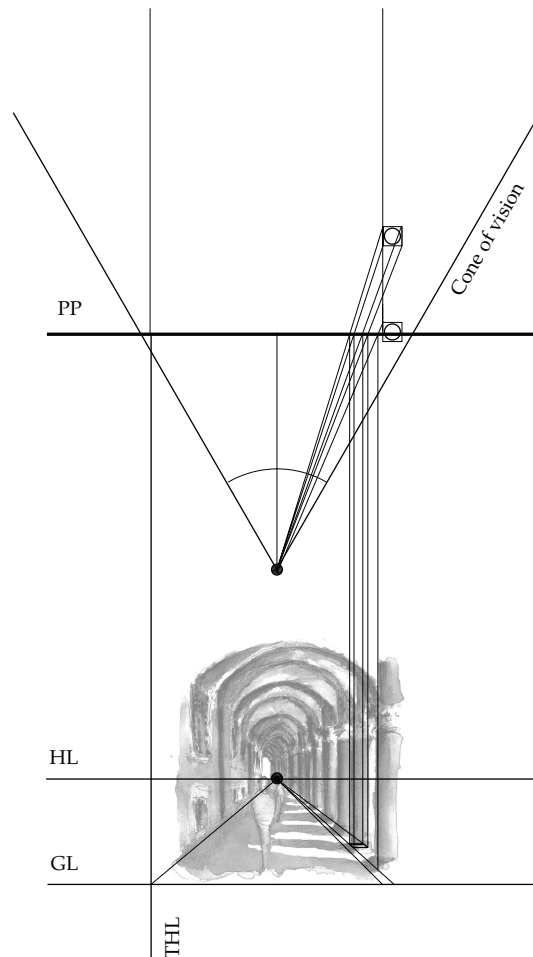


Figure 8: REP locating elements.

*Step 10.* Repeat Step 9, locating all the edges for each of the components in perspective view (Figure 9).

These two last steps depend on the use of descriptive geometry, and the elements are filled in as the steps are repeated. If we know the relative size of one of the elements, based on proportion relationships, we can give the drawing scale (Figure 9).

#### **4.4. Seeing Inside a Natural Perspective**

The unique phenomenon of this natural perspective view is the angled pathway which extends beyond the observers point of view. The REP method, is able to locate this angled path in plan and determine its length (Figure 7). However, we are still left with the unknown of the geometries outside the observers line of sight. One approach is to continue the already drawn geometries which in turn begins to reveal geometries beyond the line of sight (Figure 10).

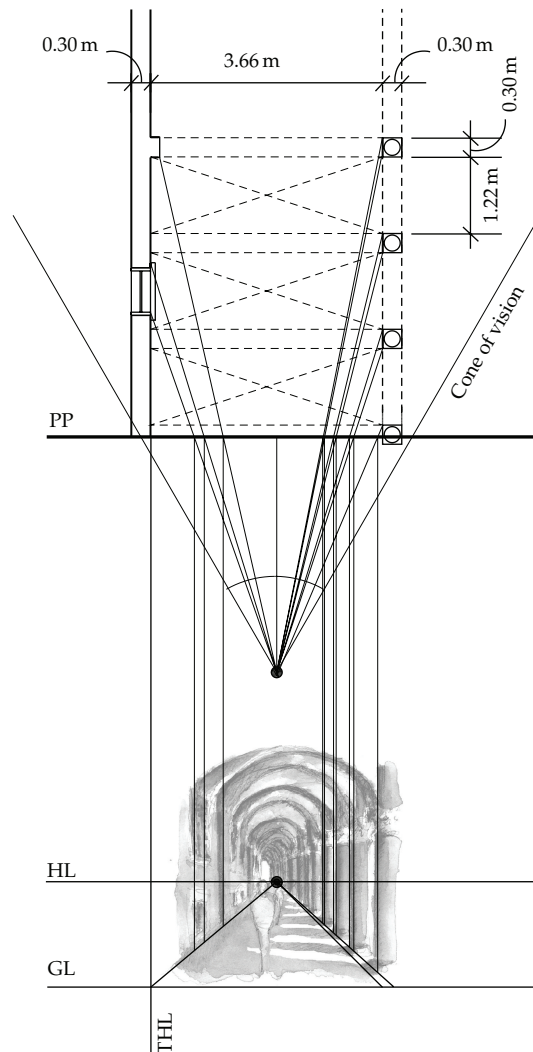


Figure 9: REP projecting elements.

*Step 11.* Fill in missing geometries in order to complete the plan, by continuing the rhythms, scale, shapes, and proportions already drawn in plan view from the projected perspective (Figure 10). Continue these geometries along the true angle line not see in the perspective view (Figure 11).

The ability to draw what is not inherently seen, is not to just a matter of guessing, but is rather drawing as insight from the knowledge gained from the previously achieved reversed engineered perspective steps [5].

## 5. Conclusion

Not only does this method puts forward the potential for designing in perspective view first prior to a developed plan, but also may provide valuable insight into the question of “why”

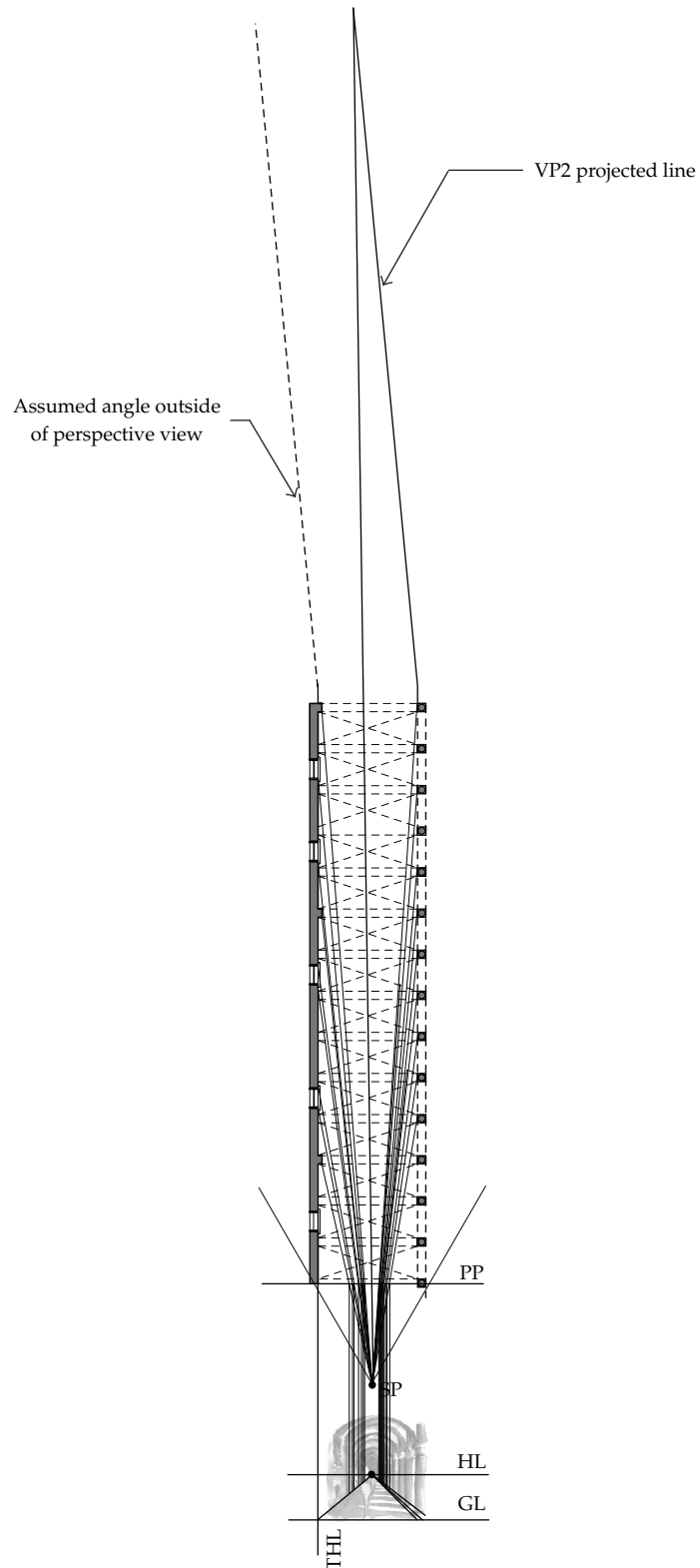


Figure 10: REP projecting elements from vanishing point 1.

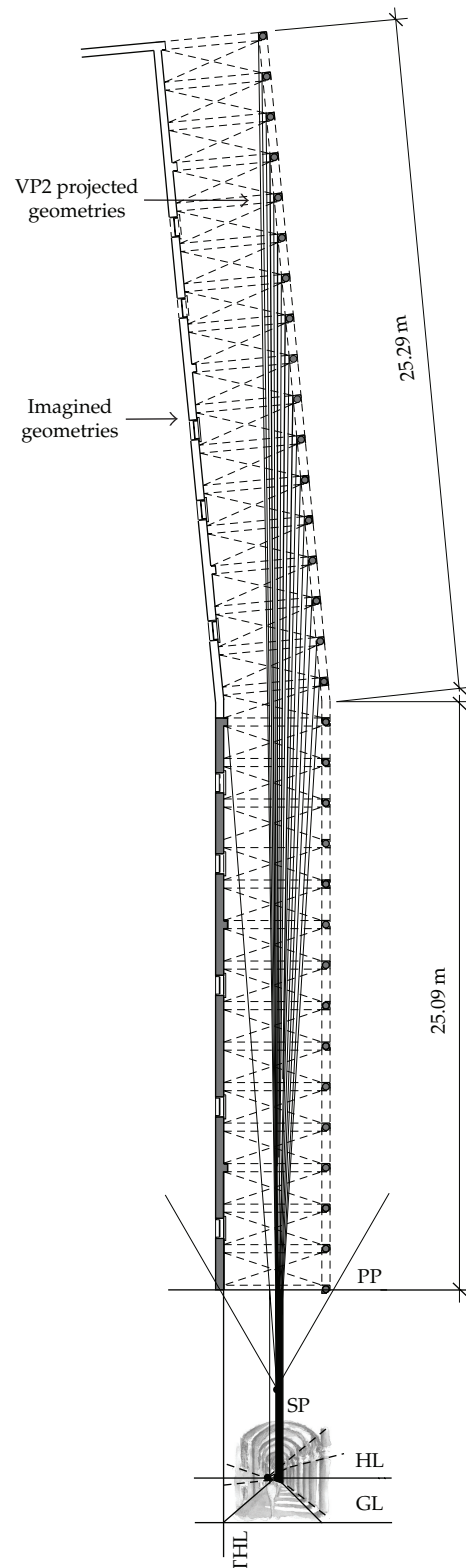


Figure 11: REP projecting elements from vanishing point 2.

a design has feeling, by connecting what we see expressively with a projected measurable floor plan. The plan view which follows from the reverse engineering perspective method is in support for the feeling of the visual perspective scene. In other words, the REP method is a pathway which bridges ones perspective vision with geometry.

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