

GEOMETRIC PROJECTOR*

By S. Joseph (Joe) DeMarco

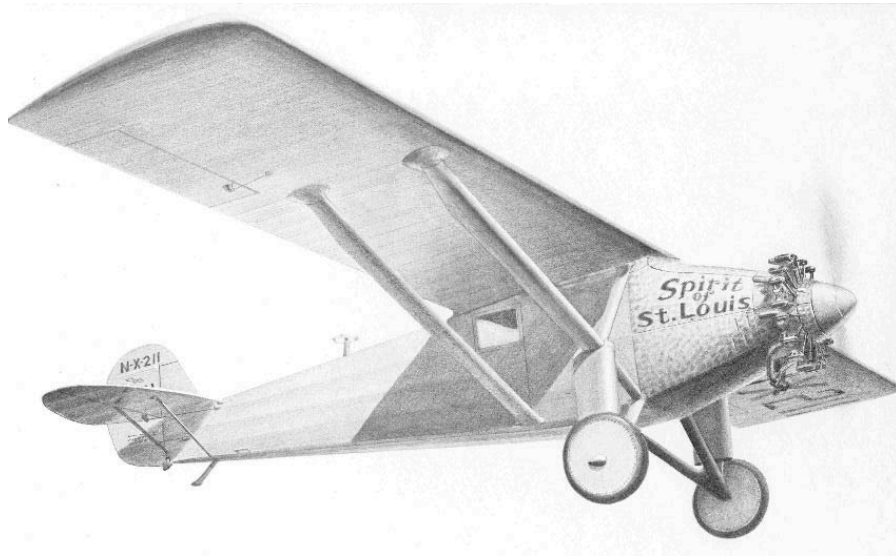


FIG. 1 — *Spirit of St. Louis*: A pencil rendering by Joe DeMarco.

Overview – The GEOMETRIC PROJECTOR (GP) is a drawing board method for converting points on a 3-view drawing into a pictorial image on a two-dimensional picture plane—in plain words, a method for making a “perspective” drawing. It’s a highly effective tool for making accurate perspectives. Most treatments of perspective assume a vertical picture plane and a horizontal line of sight at eyelevel above the ground that foreshorten only the horizontal lines that recede to one or two vanishing points. They ignore the more natural *three vanishing-point* view. GP provides the correct number of vanishing points for whatever view is taken.

The system described here was conceived by the author in 1943. It is quite unambiguous and straightforward. It is adaptable to any art genre that requires accurate perspective drawings. It is particularly well suited to the needs of aviation artists whose paintings more often than not embrace all three dimensions and cover vast regions of not only airspace, but land and sea as well. Although vanishing points are inherent in the system, GP does not rely on their use because they are frequently inaccessible on the average-size drawing board.

With GP, the range of viewing aspects is global. GP is a “hands-on” drawing system that uses the fundamentals of geometry. (The mathematical equations for ARTISTS’ PERSPECTIVE MODELER, described elsewhere in this Website, are derived from GP.)

The GEOMETRIC PROJECTOR METHOD and its operation are described in the following pages. The *object* used to illustrate the system is a simplified version of the Ryan NYP airplane, *Spirit of St. Louis*, shown in **Fig. 1**.

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JOE DEMARCO'S GEOMETRIC PROJECTOR

METHOD DESCRIBED

The first requirement for making a perspective projection is an accurate **three-view** drawing of the airplane (or other object) you wish to draw. (If you wish to follow the procedures by making a hands-on drawing of your own, a three-view in the form of a simplified version of the *Spirit of St. Louis* is provided at in Fig 7.) In addition to the three-view and a suitable drawing surface, the following items are also suggested:

- Good quality 1/10-inch-grid graph, or tracing vellum.
- An accurate ruler (decimal scale recommended.)
- A 30-60 triangle.
- A T-square or similar long, flat straightedge.



The WORKSHEET – The procedures for setting up the worksheet (**Fig. 2**) and projecting plot points to the picture plane (**Fig. 3**) are described in the following steps. The worksheet consists of two contiguous areas, the **Horizontal Plane** and the **Profile Plane**.

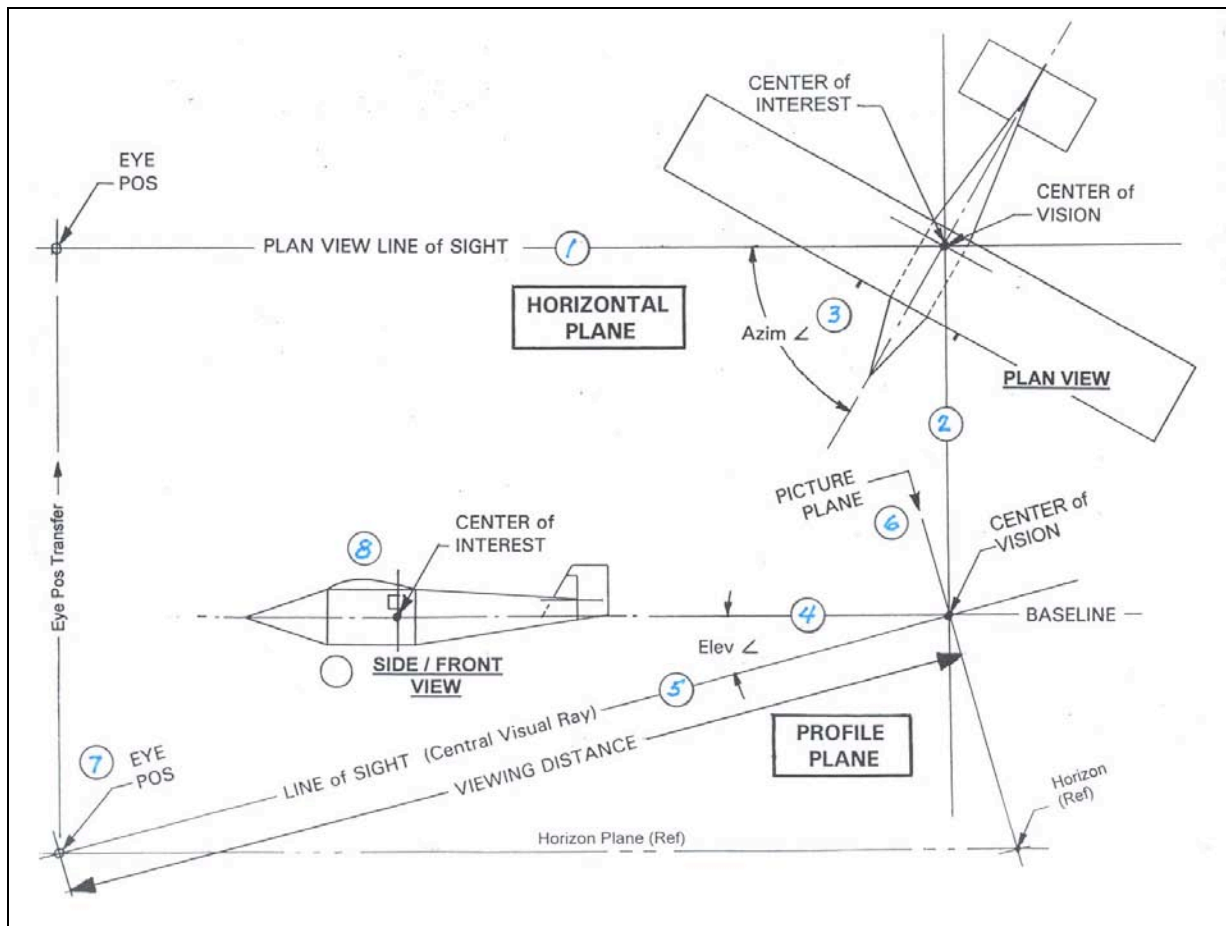


Fig. 2 — All of the essential elements for a perspective projection are identified in this typical worksheet arrangement. (In this illustration, the Azimuth and Elevation viewing angles are set to project a right front 3/4 view of the airplane from below. Also see Fig 4 and Fig. 8.)

In the Horizontal Plane:

1. Lay in the Plan View Line of Sight (PLOS).
2. Intersect PLOS with a vertical that extends into the Profile Plane area. (The intersection of these lines is at the plan view Center of Vision (**CV**)).
3. Place the airplane Plan View on PLOS at the desired Azimuth (**Azim**) viewing angle with its Center of Interest, **CI**, coincident with CV.

In the Profile Plane:

4. Let a Baseline (BL) – parallel to PLOS – intersect the vertical at CV (seen from the side.)
5. Through CV, lay in the Line of Sight (LOS/CVR) at the desired Elevation (**Elev**) viewing angle.
6. Lay in the Picture Plane (PP) perpendicular to LOS. (In the Profile Plane, PP is ALWAYS seen edge-on as a line perpendicular to LOS.)
7. Mark the Eye Position (**EP**) on LOS at the desired Viewing Distance (Dist) from CV. (The distance between EP and CV in the Profile Plane is the **true length line of sight distance** of the perspective.) Transfer EP vertically and mark a similar EP on PLOS.
8. Place the airplane Side View (and/or Front View) with its CI on BL at a convenient place on either side of the vertical line.

NOTE: (The Plan View provides LENGTH and WIDTH data. The primary purpose of the Side view is to provide HEIGHT data—the third dimension—thus, it doesn't matter if the airplane points to the left or right. The Side View is usually sufficient for the purpose, but the Front view may be necessary to provide wing dihedral, multiple engines, wheel caster and similar features not clearly discernible in the Side View. If the Front view is required, it may be placed either over the Side view or elsewhere on the Baseline.)

This completes the setup. The worksheet is now ready for the perspective projection; see topic **Making the Projection**, and **Fig. 3**.



MAKING THE PROJECTION – The straightforward 6-step transition of point **T** from the Plan and Side views on the worksheet to its perspective coordinates **X** and **Y** is shown in **Fig. 3**. The transfer of **X** and **Y** to the picture plane is shown in **Fig. 4**. This procedure is typical for all points required to complete the projection.

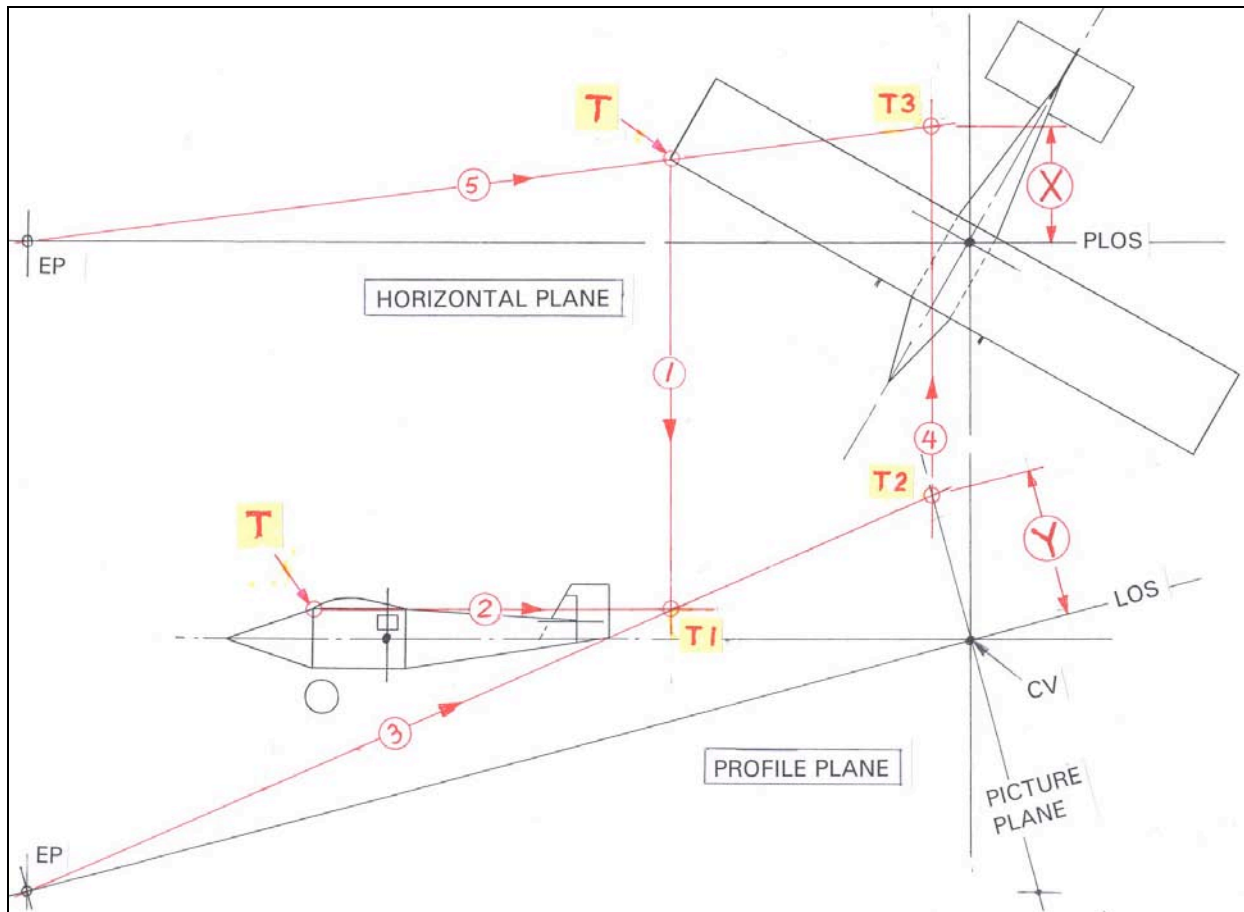


Fig. 3 — Illustrating the five steps for translating a typical point (**T**) from the Plan and Side views into its **X Y** picture plane coordinates.

1. From the Plan View (in the Horizontal Plane) drop point **T** via line **1** into the Profile Plane.
2. Translate point **T** from the Side View (or Front View, whichever is more suitable) via line **2** to intersect line 1 at **T1**
3. Let the line of sight, line **3**, extend from **EP** through **T1** to pierce the Picture Plane at **T2**.
The dimension **Y** (between LOS and T2) is the elevation coordinate for the perspective of point **T**.
4. Translate **T2** via line **4** into the Horizontal Plane.
5. Let line **5** extend from **EP** through **T** to intersect line 4 at **T3**.
The dimension **X** (between PLOS and T3) is the azimuth coordinate for the perspective of point **T**.
6. Measure and transfer the **X** and **Y** coordinates from steps 3 and 5 to the picture plane grid. See **Fig. 4**.

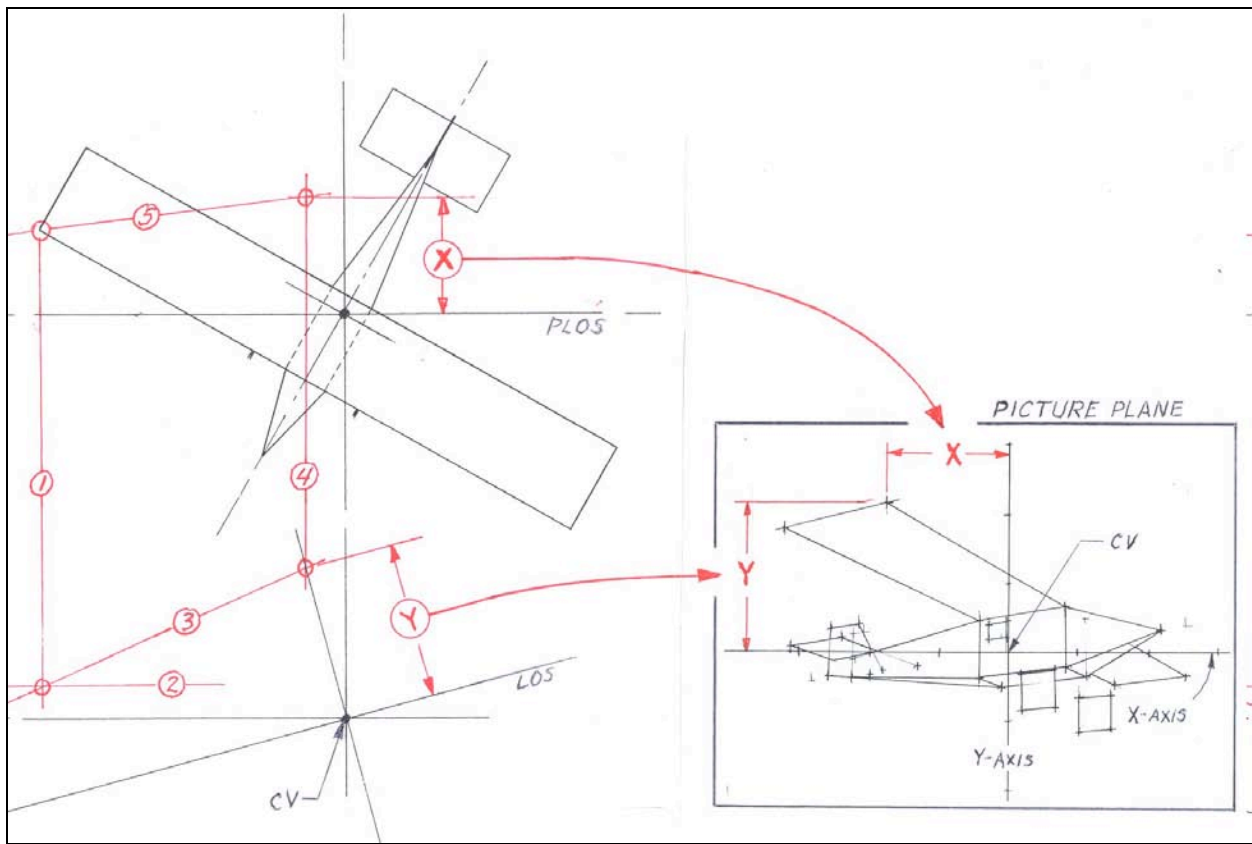


Fig. 4 — The X and Y coordinates on the worksheet (left) are measured and transferred to the picture plane (right.) X coordinates are measured to the left or right of CV, parallel to the X-axis.
 Y coordinates are measured above or below CV, parallel to the Y-axis.

Repeat steps 1 through 6 for each point desired to complete the perspective. (The completed drawing is shown in Fig. 5.)

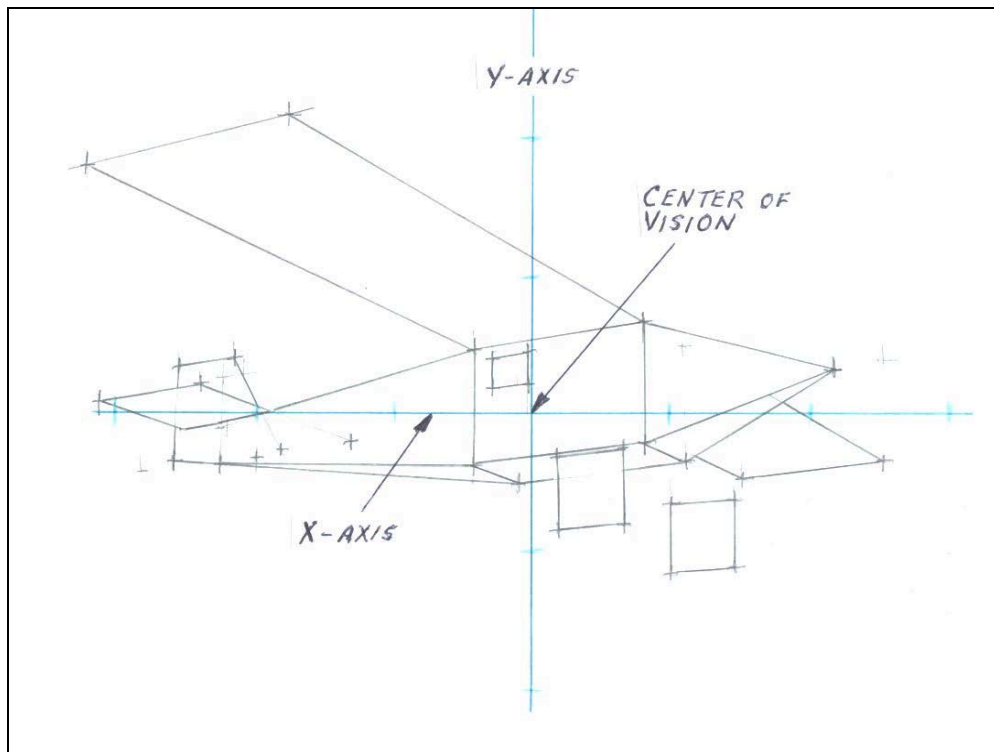


Fig. 5 — The completed projection made from the 3-view (Fig. 8.) The grid marks on the X-Y axes are at 1-inch intervals to assist in plotting.

NOTES –

- The image produced by the 6-step procedure makes a drawing 1-to-1 size with the 3-view—in the example, it’s about 6 inches wide. To make a larger image directly on the Picture Plane without the necessity of photocopying or other means of enlargement, multiply each X-Y coordinate pair by an enlargement factor and plot the points on an appropriately sized grid. E.g., to make a 12-inch image, use an enlargement factor of 2,
- No matter the viewing aspect of the airplane (object) the basic format arrangement of the worksheet remains unchanged; note the following characteristics in **Fig. 6** and **Fig. 7**.
 - The Baseline (BL) is parallel to the Plan View Line of Sight (PLOS.)
 - The Center of Vision (CV) on both BL and PLOS are in vertical alignment perpendicular to PLOS.
 - The Picture Plane (PP) has a **constant right angle relationship** with the Line of Sight (LOS), regardless of the Elevation angle.
 - The Viewing Distance (Dist) is measured between the Eye Position (EP) and the Center of Vision (CV) on the Line of sight (LOS.)
 - The Eye Position (EP) on PLOS is in vertical alignment with EP on LOS.
- In the 6-steps described in MAKING THE PROJECTION, lines were used to show the origin, direction and termination points of lines 1 through 5. Obviously, if you were to draw those lines for every point required to make the perspective (ref: Fig. 3) the layout would soon become hopelessly cluttered. Actually, tick marks (+) at points T1, T2 and T3 will suffice.
- The direction of transfer of points between the Horizontal Plane and the Profile plane via lines (1) and (4) must be parallel to the vertical line. Similarly, points transferred from the Side and/or Front view via line (2) must be parallel to the base line. This is usually done using the “Triangle and T-Square” method. A less awkward method is to use a ruler or dividers to measure the distance of the points T and T2 from the vertical line and transfer those dimensions to points T1 and T3. Similarly, measure the distance of point T in the Side and/or Front View from the baseline for transfer to point T1.

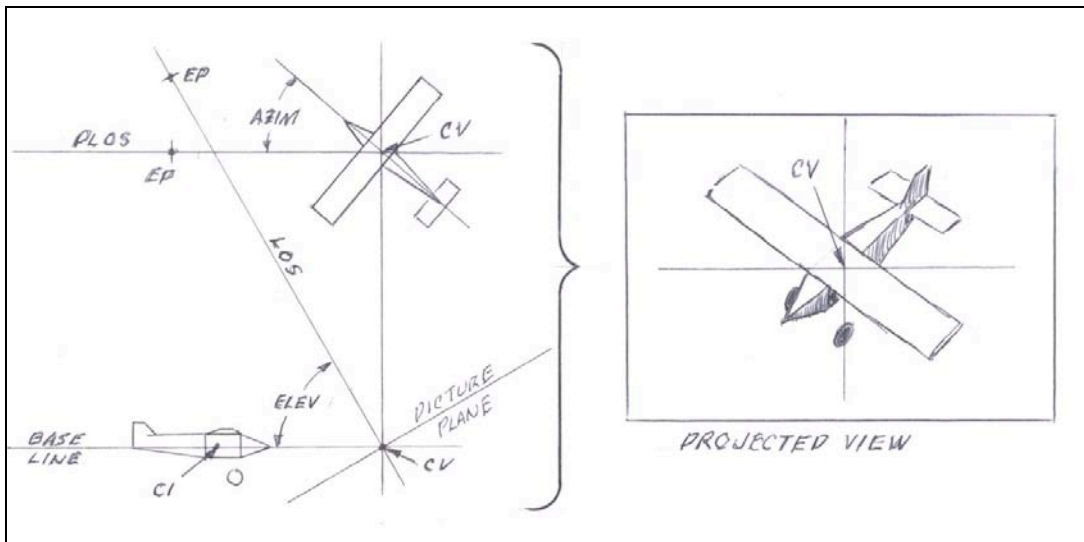


Fig. 5 — A high elevation angle in the layout (left) will produce a projected image similar to that shown in the sketch (not to scale) at the right. Note that EP on PLOS is projected vertically from EP on LOS. It is not usually important whether the Side View in the layout faces left or right

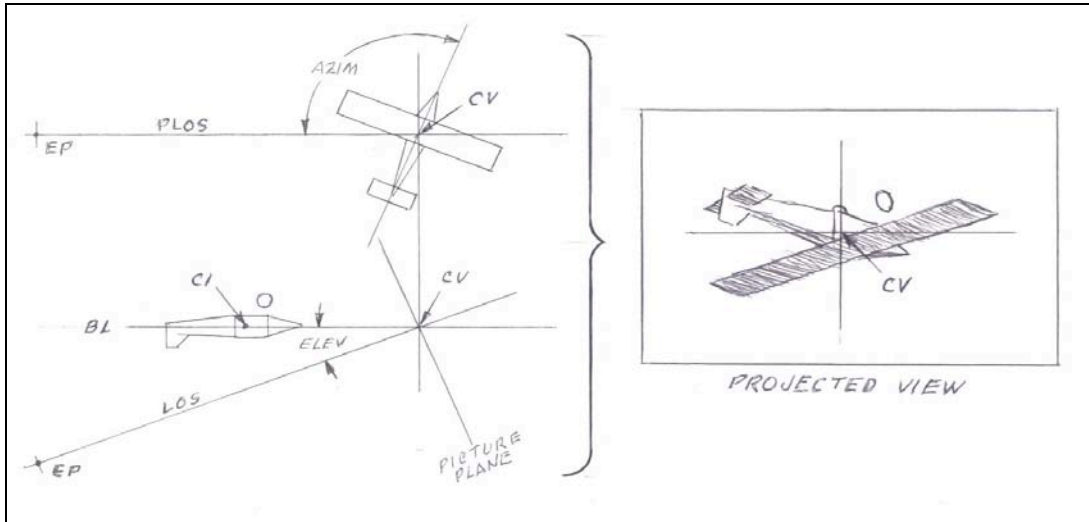


Fig. 6 — In the layout (left) the Side View is inverted to produce the inverted image shown in the projected view sketch (not to scale) on the right. Note again that EP on PLOS is projected vertically from EP on LOS.



Questions? Comments? joedemarco@aviart.info

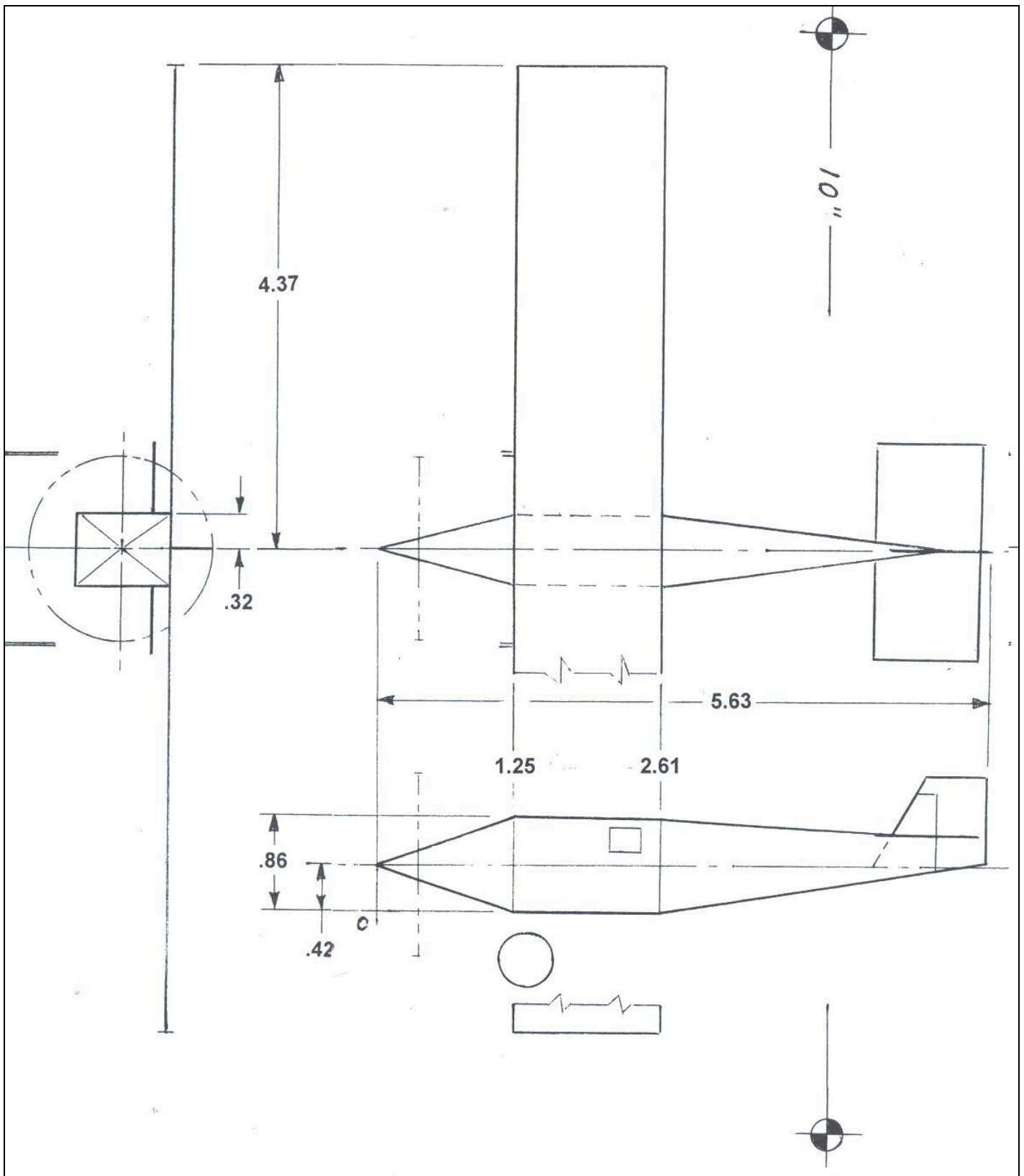
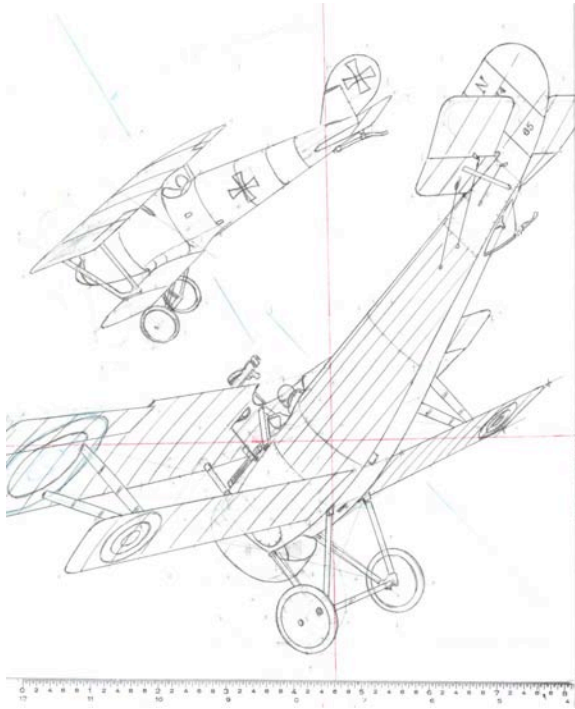


Fig. 7 — 3-view of *Simplified Spirit of St Louis*. (To make this drawing to scale, enlarge it to 10 inches between the target mar)



I hope you find the ARTISTS' PERSPECTIVE MODELER useful and interesting. Your questions, comments and suggestions are welcome.



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APM Software...

The software for the ARTISTS' PERSPECTIVE MODELER (APM) system described in this User's Guide is on a CD. It contains two spreadsheet programs; a basic "clean" one, and another with the input and output data for the subject airplane in the User's Guide. Also on the disk is an "Offsets Generator" program and instruction for its use.

The APM software requires Microsoft Excel 97 or later. It's for use on a PC but it has also been tested on Excel X for Macintosh.

The price is \$69.95 (USD) for the package. Personal checks, money orders, cashiers checks, or certified checks, made out to *S. J. DeMarco*, are accepted.