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Descriptive Geometry and Perspective in a Unified Way with GeoGebra

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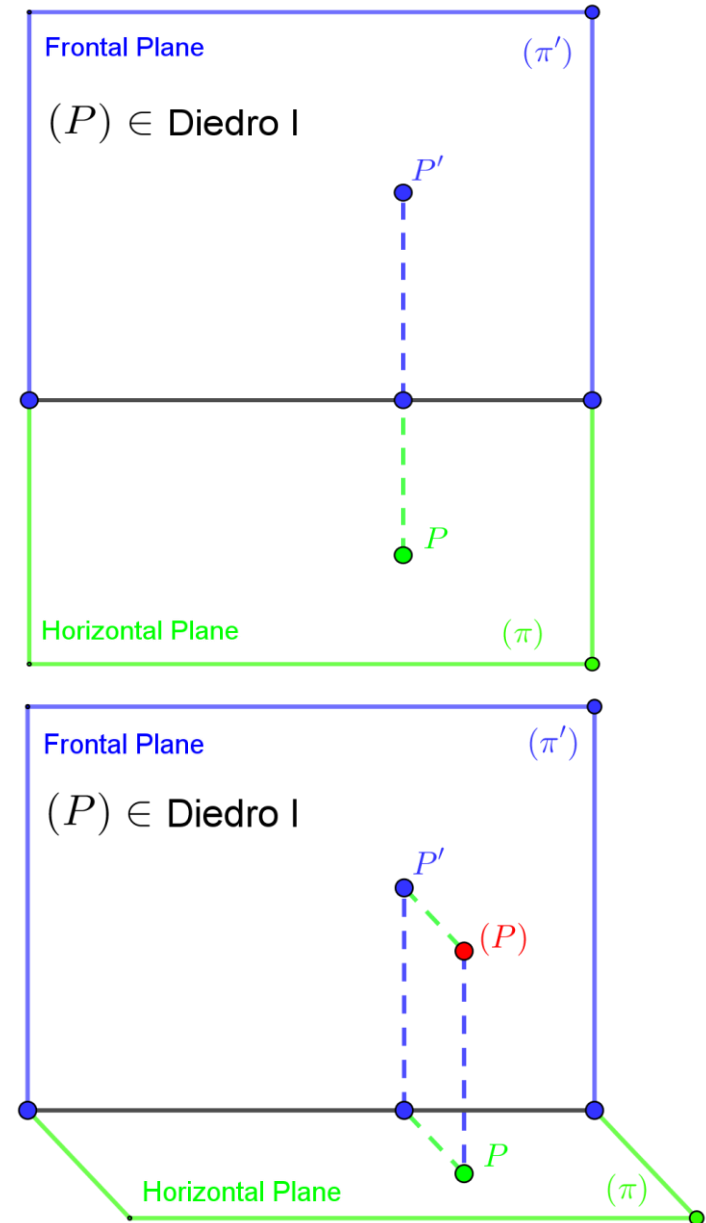
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Motivation

- Some students of descriptive geometry have difficulties in spatial visualization of objects represented in its two adjacent views.
- The construction of perspective drawings (using only parallel projections) is useful in the spatial visualization of descriptive geometry views.
- We propose the use of GeoGebra in the visualization of objects in two views of descriptive geometry and also in perspective of a unified mode, in only one GeoGebra graphics view.

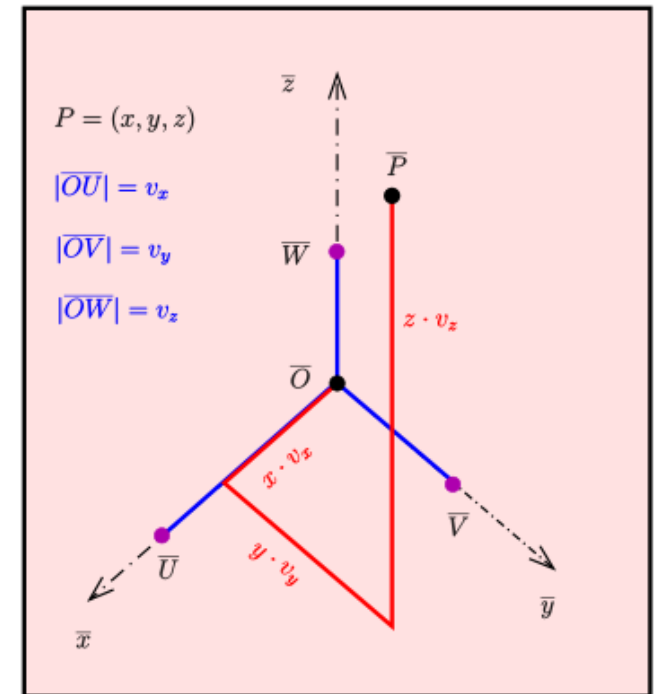
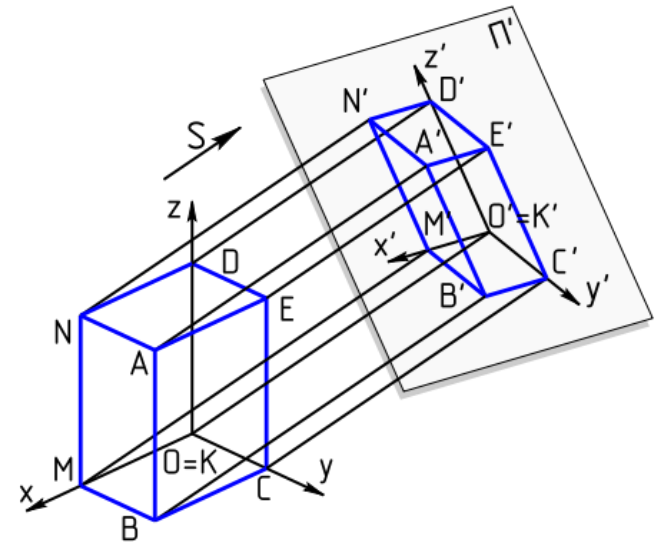
Descriptive Geometry Course

- Background: Geometric Constructions and Geometry.
- Spatial visualization and Perspective.
- Descriptive Geometry
 - Orthogonal (parallel) projection of an object in two planes of projection: the frontal and horizontal plane.
 - Two adjacent views: These two views (frontal and horizontal) are represented in the same picture.



Parallel Projection

- Projection of an object in three-dimensional space onto a projection plane, where the *rays* are parallel to each other.
- Perspective based on parallel projection is simple to build.
- Let x, y, z a $3D$ base and $P = ax + by + cz$. The projection of P is $P' = ax' + by' + cz'$
 - x', y', z' are the parallel projections of x, y, z .
 - P', x', y', z' are $2D$ vectors
 - a, b, c are real numbers



Pictures from Wikipedia

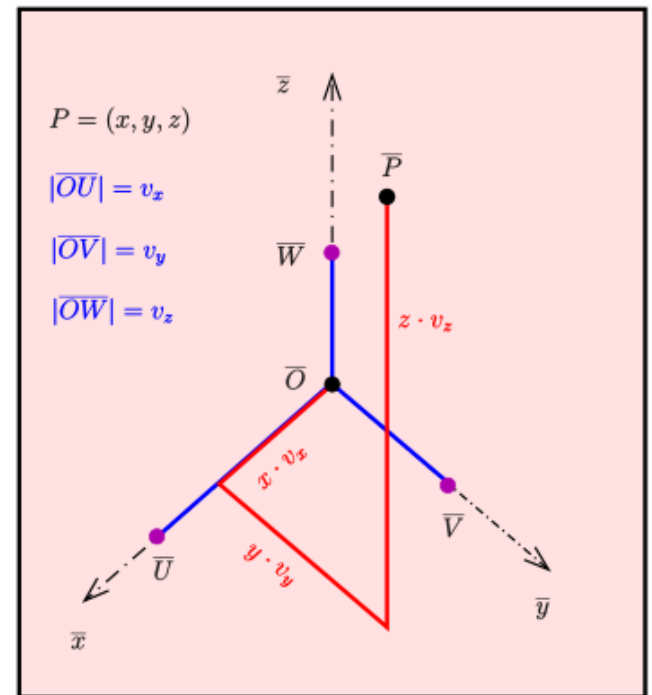
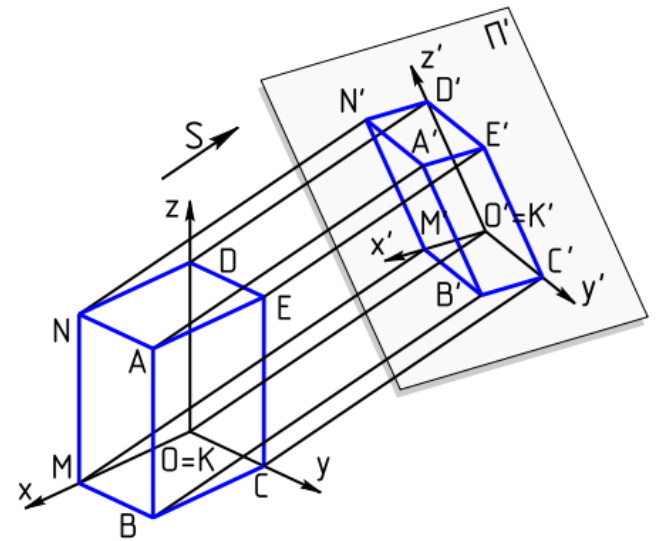
Perspective based on parallel projections

$P' = ax' + by' + cz'$, where

- P', x', y', z' are 2D vectors
- $|x'| = r_x * |x|$
- $|y'| = r_y * |y|$
- $|z'| = r_z * |z|$
- r_x, r_y, r_z are the contraction factor of the axes (real numbers)

Who are x', y', z' and the values of r_x, r_y, r_z ?

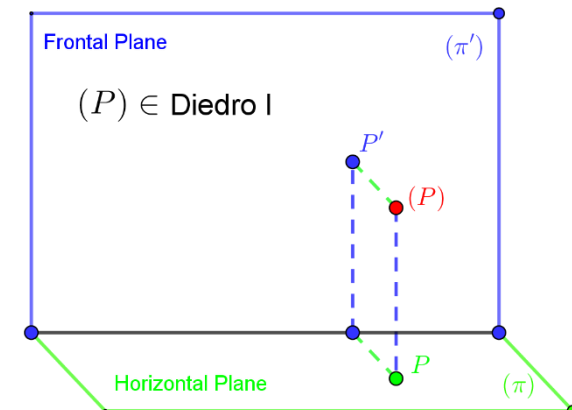
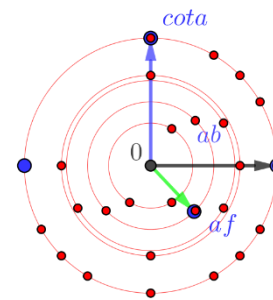
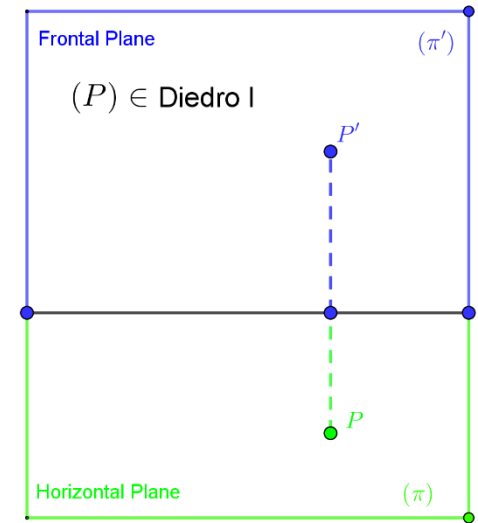
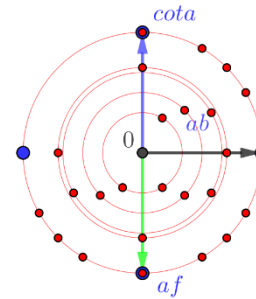
- Axonometry
- Let the user choose



Pictures from Wikipedia

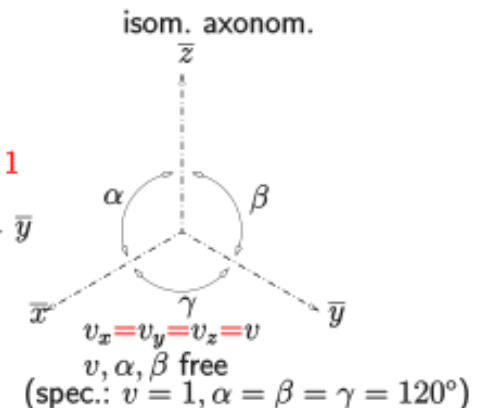
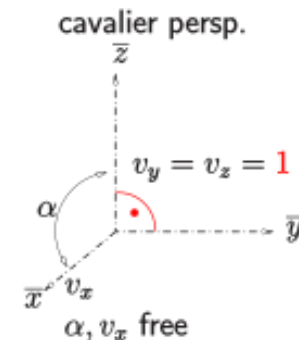
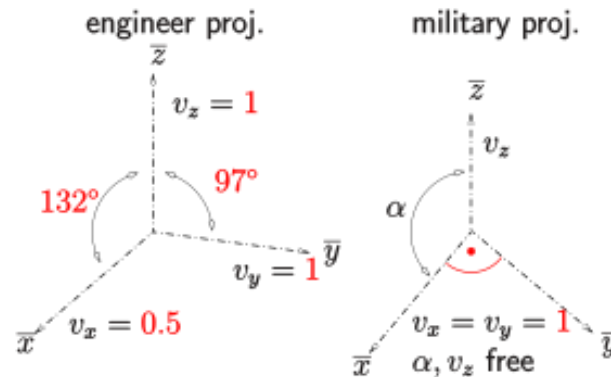
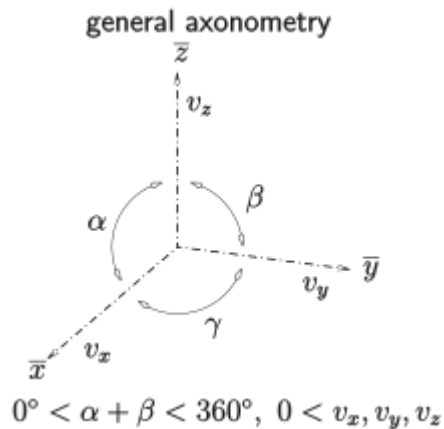
Descriptive Geometry and Perspective

- Descriptive Geometry coordinates = Base of the **3D** space: abscissa, afastamento, cota.
- Let's consider that these axes represented in the descriptive geometry picture are the projected axes of the perspective.
- Moving these axes we have a perspective **3D** visualization.
- Display **3D** information only if angle between afastamento e cota differs from **180** degrees.



Common types of Perspective

	Alpha	Beta	r _z	r _x	r _y
Cavaleira, Alpha=120	120	90	1	2/3	1
Cavaleira, Alpha=135	135	90	1	1/2	1
Cavaleira, Alpha=150	150	90	1	1/3	1
Militar	135	135	1/2	1	1
Isometria	120	120	1	1	1
Engenheira	132	97	1	1/2	1



Pictures from Wikipedia

Examples

- The point and its position
- The line and its features
- Plane and intersections
- Rotation method with vertical axis
- Polyhedra

References

- GeoGebra web page: <https://www.geogebra.org/>
- Wikipedia pages: Axonometry, Axonometric projection, Descriptive geometry, Parallel projection
- A. R. Príncipe Júnior, Noções de Geometria Descritiva, vol. 1 e 2.
- Hawk, M. C., Descriptive Geometry, McGraw-Hill, 1962.
- Notas de Aula de Anderson Mayrink da Cunha