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The Observable Structure of 4-Dimensional Perspective Cone Projection

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These are the results of experiments during observations of counting coordinate axes and determining the shape of 4-Dimensional perspective cone projection and also for comparison material of a 3-Dimensional perspective cone projection. They have been executed in real space with real projection, recored with the eye and camera as an observer. Mentioned angles can be determined with a protractor triangle. The projection technique used *[ref1.]* during the experiments.

- *[ref1.] https://www.twoeyedmonocularvision.com/_files/ugd/52ede2_75ad73c903284eb9890d94486104d76b.pdf*
- *[ref2.] https://mathinsight.org/applet/spherical_coordinates_constant_phi*
- *[Figure A.]* The structure of 4-Dimensional perspective cone projection.
- *[Figure B.]* The structure of 3-Dimensionale perspective cone projection.

Presented findings 4-Dimensional coordinate w-axis which runs on/ parallel as close as possible to the optical axis. A set of four 4-Dimensional coordinate axes x, y, z, w. Coordinate axes x, y, w work together dominantly as a set of three to make 4-Dimensional perspective cone projection observable.

3D/4D three-axes duality, that the amount of three coordinate axes that work together dominantly as a set of three are dual in 4-Dimensional perspective cone projection (namely the x, y, w axes as a set of three) and in 3-Dimensional perspective cone projection (namely the x, y, z axes as a set of three).

The purpose of this research is to show that in addition to the already known 3-Dimensional cone projection, there exists another dimensional cone projection shape that cannot be lower dimensional but rather must be higher dimensional.

4-Dimensional Perspective of a Cone Projection

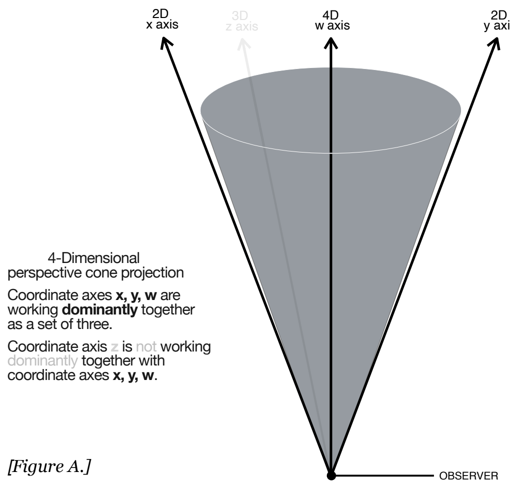
Not-distorted cone projection

Four coordinate axes x, y, z, w in real space. After execution, the the z-axis will no longer be dominant but instead the w-axis will be dominant, which makes three axes x, y, w results in 4-Dimensional perspective cone projection.

By going on the w-axis, angles are avoided, resulting in a not-distorted perspective cone projection.

The 4-Dimensional w-axis found runs on/parallel as close as possible to the optical axis.

Based on a not dominant presence of the 3D z-axis which is responsible for 3-Dimensional perspective cone projection.



[Figure A.]

The 4-Dimensional perspective cone projection is performed according to the *[ref1.]* technique. From the observer, whether with one-eye or a recording camera, a cone is projected not at angles to the optical axis which is the coordinate w-axis of the observer and this with a light beam from a flashlight, from an image projector and from a shadow and this on a frontal, so-called flat wall, as well as on skewed walls. The cone projection shows a not-distorted inside space and a not-distorted surface and its own characteristic depth effect and therefore its own dimensionality. In order to be able to determine and illustrate the structure of 4-Dimensional perspective cone projection as done in *[Figure A.]* during the observation, the shape of the surface and the shape of the inside space of the projected cone were looked at, specifically.
The coordinate axes are also counted. The 4-Dimensional coordinate w-axis acts as a dominantly present axis. A 2-dimensional perspective cone projection cannot be found anywhere and therefore cannot be isolated and observed. Nevertheless, in *[Figure A.]* the 2-Dimensional coordinate axes x, y are included because these axes are widely accepted (if it is considered not to include the x, y, axes then this will not change the shape structure of the cone and will also not change the fact of the different dimensionality of this dimensional perspective cone projection in real space and how it is drawn in *[Figure A.]* compared to the 3-Dimensional perspective cone projection from *[Figure B.]*). The 3-Dimensional coordinate z-axis is not dominantly present and is therefore indicated as gray in *[Figure A.]*. Through its own coordinate axes x, y, w, this cone projection shows its own dimensionality.

3-Dimensional Perspective of a Cone Projection

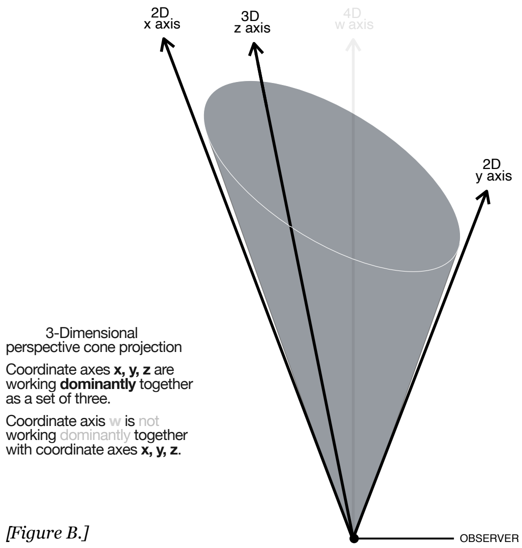
Distorted cone projection

Four coordinate axes x, y, z, w in real space. Three coordinate axes x, y, z results in 3-Dimensional *[ref2.]* perspective cone projection.

By going on the z-axis, angles are created, resulting in a distorted perspective cone projection.

The 3-Dimensional z-axis does not run on/not parallel as close as possible to the optical axis.

Based on a not dominant presence of the 4D w-axis which is responsible for 4-Dimensional perspective cone projection



[Figure B.]

The 3-Dimensional perspective cone projection is performed according to the *[ref1.]* technique. From the observer, whether with one-eye or a recording camera, a cone is projected at angles - off the optical axis which is the coordinate w-axis of the observer and this with a light beam from a flashlight, from an image projector and from a shadow and this on a frontal, so-called flat wall, as well as on skewed walls. This cone projection shows a distorted inside space and a distorted surface and its own characteristic depth effect and therefore its own dimensionality. In order to be able to determine and illustrate the structure of 3-Dimensional perspective cone projection as done in *[Figure B.]* during the observation, the shape of the surfaces and the shape of the inside space of the projected cone were looked at, specifically.
The coordinate axes are also counted. The 3-Dimensional coordinate z-axis acts as a dominantly present axis. A 2-dimensional perspective cone projection cannot be found anywhere and therefore cannot be isolated and observed. Nevertheless, in *[Figure B.]* the 2-Dimensional coordinate axes x, y are included because these axes are widely accepted (if it is considered not to include the x, y, axes then this will not change the shape structure of the cone and will also not change the fact of the different dimensionality of this dimensional perspective cone projection in real space and how it is drawn in *[Figure B.]* compared to the 4-Dimensional perspective cone projection from *[Figure A]*). The 4-Dimensional coordinate w-axis is not dominantly present and is therefore indicated as gray in *[Figure B.]*. Through its own coordinate axes x, y, z, this cone projection shows its own dimensionality.

Summary
• Two different types of perspective cone projections with their own dimensional shape have been observed. • 3-Dimensional and 4-Dimensional perspective cone projection are experimentally isolated. • The z-axis and w-axis are isolated when they work dominantly together in their own set of three axes. • The 4th coordinate w-axis is assigned here to the optical axis which is mentioned in *[ref1.]* • 2-dimensional perspective cone projection could not be found but the x and y axes are included in this framework under the assumption that it exists, with the reason that 2-Dimensional is widely worked with in science and also because of its extreme flatness it would not be viable for making a cone projection. Therefore, these cone projections are constructed and explained, including the current 2-Dimensional assumption. • A set of four 4-Dimensional coordinate axes x, y, z, w.

• The amount of three coordinate axes of the 3-Dimensional perspective cone projection, which uses the long-known three dominant coordinate axes x, y, z, are dual to the amount of three coordinate axes x, y, w of the 4-Dimensional perspective cone projection, which is related to how access for observing a 4-Dimensional perspective cone projection is possible, even if it is only a boundary part observed of the 4-Dimensional perspective cone projection and not the full access to observing the 4-Dimensional perspective cone projection.

Under the old assumption when the w-axis, which is the optical axis, was not yet found and included as a true Dimensional axis:
It is pointed out that in some situations in the past, the now newly found understandable 4-Dimensional perspective cone projection with their three coordinate axes x, y, w, used only the two axes x, y instead of the three axes x, y, w. This may have resulted in the past current 4-Dimensional perspective cone projection being misunderstood as 2-dimensional.