Description of the three-dimensional scenic space design process

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The Roman architect Vitrubio, who lived in the 2nd century, described in his fifth book of architecture how the Greeks and Romans introduced on stage in their theatres three triangular prisms in which they painted the scenes corresponding to the three acts in which every classic play is divided.

Turning over its own axis, the representation of the three different settings appeared successively placed on the faces of three triangular prisms.

Nowadays, this system has been used again in an innovative way, by means of the multiplication of prisms to make advertising placards which show three different aspects.

Diagram 1
Ground plan of Roman theatre.

Patent Smith Theatrical Scenery Device
USA JULY 1915.
The geometric investigation about the movement compatibility between closed packing spheres in maximum density shows that the simultaneous turn of closed packing spheres starting from a structure of twelve tangent spheres is possible. In this way the movement of the system spreads out in space and it is indefinitely continuous producing longitudinal and wavy movement.

Diagram 2
Group of twelve mobile spheres which are tangent among themselves, surrounded by six external ones whose relationship of diameters is 1/3

Diagram 3
Mobile group of two octahedric structures of tangent spheres
If the twelve spheres inscribed in the octahedron axes are substituted by cones circumscribed in those spheres and placed over the same axes, and if three dihedral sectors are placed over those cones in which we can place different sceneries we shall have defined a new design of three-dimensional scenic variation.

(Diagram 4)
Longitudinal movement associated to the rotation of twelve tangent spheres in ortahedric axes structure (left).
Substitution of the spheres by double cones (middle).
Substitution of cones by gearing. (right)

(Diagram 5)
Rotatory sphere turning round an axis; substitution by its circumscribed cone and dihedral sectors in which the scenery is placed.
If the study of three-dimensional variation is extended to all the polyhedra we deduce that only few of them have the precise conditions of periodic transformation.

**THE OCTAHEDRON** | **THE CUBE** | **THE TETRAHEDRON** | **THE ROMBIC DODECAHEDRON**

(P Diagram 6 )
Polihedra which allow the three-dimensional scenic modification.

The methodology of investigation is simple. It consists in dividing every polygonal face of a polyhedron in equal sectors coincidental in the middle of its face, making them turn around the edges after having added to every edge all the necessary number of sectors which form dihedral angles, which are the same as the ones on the faces of the polyhedron.

(P Diagram 7 )
Polyhedra of scenic transformation with the complementary dihedral sectors introduced in their edges.

The turn of the edges which are united to these divisions of the faces will produce a periodic variation which can be seen from the inside of the polyhedron.

Inside every dihedral sector, different settings or three-dimensional, real mock-ups can be placed, and will be able to be seen from inside the polyhedron, so that performances can be played, in which everything that surrounds the audience changes in the total three-dimensionality of space: up, down and sides.
Floors, elevations and perspective of the dihedral elements of the scenic variation polyhedra.
From the architectural point of view there are numerous possibilities of design depending on the chosen polyhedron.

The size of the scenic variation is variable, from small display cases of 30 cm to domes of 30 metres of diameter. In the total modifications of the space, the inside of the scenery is seen from a bridge or platform which goes diametrically across the polyhedron. The bridge is introduced by removing part of the dihedral sectors.

The mechanism in the octahedric system is the simplest of all, as the octahedron has movement compatibility (when the turn of an edge is made, they all move in continuous transmission) since every polyhedron which has an even number of edges in every vertex has movement compatibility.

Small showcases of scenic variation can be made with octahedra, cones and rhombic dodecahedra if split open or divided into two sections. They allow great didactic richness in interactive exhibitos.

If we add virtual films to this system, projected over real scenery which combine special effects, we shall be able to make fairs and museums more enjoyable.

(Diagram 9)
Front of three-dimensional scenic space with a 18 metre diameter sphere