A plurality of pieces constitute the normal edge dissection of a polyhedron shell. Selections of said pieces can be used to reconstruct the shell perfectly. Male and female keys along the edges of each piece interfit to form the edges and corners of the shell perfectly. Cubic and tetrahedral shells are illustrated. Selected pieces can be used to construct variously shaped shells. The pieces may be provided with binding holes through which binding pins may be inserted to hold adjacent pieces together.

9 Claims, 5 Drawing Figures
SECTIONED SHELL PUZZLES

SUMMARY OF THE INVENTION

Geometric shells can be sectioned in a logical way into interlocking puzzle pieces. Many piece selections of puzzle sets are possible and only a few will reform the original shell, in certain ways, perfectly. Some shell puzzles, especially the cube, can also constitute a construction block toy where derived puzzle pieces are used to build shells of larger size and different shape than that of the original shell.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the assembled, normal-edge dissection of a regular cube shell.

FIG. 2 shows a perspective view of six interlocking, planar puzzle pieces derived from the cube shell dissection.

FIG. 3 shows a binding pin.

FIG. 4 is a perspective view of the assembled, normal-edge dissection of a regular tetrahedron shell.

FIG. 5 shows an outline view of four interlocking, planar puzzle pieces derived from the tetrahedron shell dissection.

DESCRIPTION OF THE INVENTION

Any geometric solid can be conceived of as a shell, completely enclosing a single or plural hollow interiors. Geometric shells can be sectioned in logical and arbitrary ways into two or more pieces that can be regarded as constituting a puzzle. This invention concerns the regular shells of polyhedron solids, whose interior is a single compartment, whose interior and exterior surfaces are similar in shape, whose thickness is uniform, and whose edges are all line segments; particular dissections thereof called the normal-edge and the abnormal-edge shell dissection; and a certain, limited, definition of puzzle piece formation.

While any regular geometric shell having at least one edge has unique normal-edge dissection, most shells yield largely dull puzzle pieces. Other polyhedron shells, irregular, deformed, and plural compartment, and other dissections as the normal-corner dissection, the face dissection, the unit dissection, and arbitrary dissections have lesser fascination as puzzles or value as construction block toys. The normal-edge and the abnormal-edge dissection of the regular cube and tetrahedron shells are of great interest and are described in detail as examples of this method of shell dissection used to determine this class of sectioned shell puzzles.

The normal-edge dissection involves the normal dissection of shells and a further sectioning of shell edge pieces whereby interlocking male and female keys can be provided to derive puzzle pieces. The normal dissection of any regular shell proceeds as follows: Any shell having one or more corners and/or edges has an extension where every shell surface, exterior and interior, is continued beyond corner and edge boundaries to infinity, respective to functions of shape. For every point on the exterior surface of a shell and the exterior surface extension there is a uniform line segment, in the shell surfaces, having a length equal to the uniform thickness of the shell, with end points on the exterior surface or surface extension and on the interior surface or extension. Those points of the actual material of the shell are either (A) common to one and only one normal line segment, (B) common to exactly two distinct normal line segments, (C) common to three or more distinct normal line segments. That material of a shell whose points form a system of adjacency and meet above condition (A) are called face pieces of the shell; condition (B), are called edge pieces; condition (C), are called corner pieces. That material of a shell whose points are common to two or more distinct normal line segments is called the shell frame. Usually a regular shell having of its exterior surface X faces, Y edges, and Z corners will, by the normal dissection, determine X face pieces, Y edge pieces, and Z corner pieces. The frame of the shell can also be understood as the union of all edge and corner pieces, and will be disconnected only when the shell embodies a continuous curve surface.

Further sectioning of the normal dissection of polyhedron shells into the normal-edge dissection proceeds as follows: Every exterior edge of a polyhedron shell, being a line segment, can be sectioned into 3 equal segments, determining 2 section locations on every distinct exterior edge of the shell. Determined section locations will be present to the edges of the shell edge pieces (through the normal dissection) only when every exterior shell edge is greater in length than 3 or more times the shell thickness. Final sectioning, after normal dissection, is by way of flat planes, normal to the shell edges at section locations, sectioning edge pieces only into 3 parts. Section locations for the edge piece part dissection can be otherwise determined or arbitrarily positioned, however comprising key symmetry.

The assembled normal-edge dissection of a regular cube shell is shown in Fig. 1 and that of a regular tetrahedron shell is shown in Fig. 4. Any piece or connected combination of pieces of the dissection can be regarded as a puzzle piece, connected combinations considered as formed integrally. The full set of puzzle pieces of the dissection would consist of an infinite quantity of every unique combination possible. More highly defined puzzle piece sets would consist of finite quantities of variously limited combinations. One such outstanding limited set is defined as follows: Those combinations of pieces, face, edge part, and corner that (1) lie in the same plane, (2) include a face piece, (3) have for every distinct edge of the face piece either the central edge piece part adjacent thereto (male key) or the two edge piece parts adjacent to the central edge piece part (female key), (4) intrinsically include a corner piece only at adjacent female keys, (5) extrinsically include a corner piece only at adjacent male and female keys, and (6) include every possible arrangement of corner pieces present and/or absent to every possible piece of above 1.2.3.4, & 5. Corner pieces can not be present at adjacent male keys, being disconnected to the face piece at these locations.

FIG. 2 shows the pieces of the above definition, parts 1.2.3.4, & 5 derived from the cube shell normal-edge dissection, FIG. 1. The dotted lines indicate possible locations of corner pieces as of parts 4,5, & 6 of the definition. Corner pieces may be present and/or absent to pieces A in 6 different ways; to piece B in 10 different ways, to piece C in 6 different ways, to piece D in 7 different ways, to piece E in 3 different ways, and to piece F in 1 way, determining 33 differently shaped pieces in all. Considering construction of a cube shell from these
pieces, there are 48 selections of \( S(6,6) = 462 \) possible selections (definition parts 1,2,3) that provide the necessary 12 male and 12 female keys exactly. Of these 48 selections, 8 provide the proper quantity of 8, intrinsically included, corner pieces (definition parts 1,2,3,4), while the other 40 selections can be adjusted to 8 corners, in many different ways, by adding or subtracting corners (definition parts 5,6) to form the shell perfectly.

The puzzle pieces derived from the above set definition, parts 1,2,3, & 4 for the normal-edge dissection of a tetrahedron shell, FIG. 4, are shown in outline, FIG. 5. Extending the definition to parts 5 & 6, there would be 17 pieces in all. From \( S(4,4) = 35 \) selections of pieces, there are 5 that provide the necessary 6 male and 6 female keys exactly, and only one that intrinsically includes the proper quantity of 4 corner pieces exactly, that selection being the four outlined pieces K,L,M, and N of FIG. 5. An important property of a well defined set of sectioned shell puzzles is that the derived pieces be capable of building shells of different size and shape than that of the original dissection. The cube shell pieces are extremely apt in this respect and a large quantity of puzzle pieces can constitute a construction block toy. However many larger built shells could readily collapse. To prevent collapse, the pieces have binding holes, indicated on the pieces of FIG. 2 by the small circles, and can be secured together in the same and at intersecting planes by tapered binding pins, FIG. 3. In addition to the defined dissection puzzle pieces, a construction block toy can also include a variety of other blocks such as face, edge, and corner pieces of the dissection, as well as posts, columns, partians, doors, stairs, etc. These additional pieces would also have binding holes and their combination with a large set of puzzle pieces produces a block toy having extensive scope of design. Cube block pieces, buildable in many imaginative ways, can also be combined in many strange and interesting offset patterns.

The regular shells of the five regular polyhedron solids all yield fascinating normal-edge dissection puzzles. Of these, the tetrahedron is the simplest puzzle and the cube the most intriguing construction block toy. Every other polyhedron shell has a unique normal-edge dissection and an interlocking planar puzzle piece set, but, for the most part, the derived pieces fit together in few ways and are unable to build differently shaped shells extensively.

In the foregoing definition of sectioned shell puzzles, only 1 male or 1 female key is provided to the edges of planar puzzle pieces. Shell edge pieces could also be sectioned into any number of parts, in many different ways, to provide any number of keys, in any combination, to the edges of shell face pieces. Special or offset keying can limit the number of ways proper piece selections can be combined perfectly, but, in general, multi-keyed pieces have an unpleasing, unnecessarily complicated appearance.

Many various materials can be used to compose the pieces of puzzles and construction block toys. Pieces can be transparent, colored, or opaque. The puzzle container itself can be a piece or pieces of the puzzle. Pieces could also have designs or further sectioned parts, holes, or patterns, not directly related to the normal-edge or the abnormal-edge polyhedron shell dissection.

Having set forth disclosure of my invention, I claim:

1. A puzzle comprising a finite number of puzzle pieces of a normal edge dissection of a polyhedron shell, wherein selections of said pieces can be fit together to form the original polyhedron shell perfectly, each of said pieces being planar and comprising an entire face of said polyhedron shell, each piece at each edge thereof having either a centrally located male edge key with female edge keys on opposite sides thereof or a centrally located female edge key with male edge keys on opposite sides thereof, and each piece further including at each corner a male or a female key, a said selection of said pieces being equal in number to the number of faces of a given polyhedron to form the faces thereof, with the male and female edge keys of said selected pieces together forming the given polyhedron edges perfectly, and with the male and female corner keys of said selected pieces together forming the corners of the given polyhedron perfectly.

2. The puzzle of claim 1 where the section locations of the edge piece part dissection number two and are located at the interior end points of 3 equal edge segments of every exterior shell edge; and where every exterior shell edge is greater in length than 3 times the uniform shell thickness.

3. The puzzle of claim 1 where the section locations of the edge piece part dissection number two and are located anywhere on the exterior edges of shell edge pieces.

4. The puzzle of claim 1 where the section locations of the edge piece part dissection are any number 2 or more and are located anywhere on the exterior edges of shell edge pieces; and where plural edge keys are provided to each edge of each piece in a manner similar to the single-keyed pieces.

5. The puzzle of claim 1 where the exterior edges of said polyhedron shell all have the same length.

6. The puzzle of claim 5 where said polyhedron shell is a cube.

7. The puzzle of claim 5 where said polyhedron shell is a tetrahedron.

8. The puzzle of claim 1 where a finite number of said puzzle pieces provides selections of said pieces that are able to build shells of different size and shape than that of the original dissection and constitute a construction block toy.

9. The construction block toy of claim 8 where said pieces have binding holes sectioned therein and there are binding pins capable of engaging the binding holes to secure pieces together in the same and at intersecting planes.

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