A synchronised movement apparatus comprises a plurality of polyhedron blocks arranged in a first configuration, wherein adjacent blocks have a connection therebetween that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration.
X & Y AXIS

FIG. 7A

X & Z AXIS

FIG. 7B
Y & Z AXIS

FIG. 7C
FIG. 9A

Front Cubes

Rear Cubes

FIG. 9B
SYNCHRONISED MOVEMENT APPARATUS

[0001] The present invention relates to an apparatus with a plurality of components arranged for synchronised movement. The apparatus has application in one embodiment as a puzzle apparatus.

BACKGROUND

[0002] Puzzles have been known for generations and they are popular with adults and kids alike because they stimulate creative thinking and provide an intellectual challenge to the player. Rubik’s Cube™ is an example of a successful and popular spatial puzzle.

[0003] The present invention seeks to provide an alternative movable apparatus.

[0004] In this specification the terms “comprising” or “comprises” are used inclusively and not exclusively or exhaustively.

[0005] Any references to documents that are made in this specification are not intended to be an admission that the information contained in those documents form part of the common general knowledge known to a person skilled in the field of the invention, unless explicitly stated as such.

SUMMARY OF THE PRESENT INVENTION

[0006] According to an aspect of the present invention there is provided a synchronised movement apparatus comprising a plurality of polyhedron blocks able to be arranged in a first configuration, wherein adjacent blocks have a connection therebetween that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks so as to be arranged in a second configuration.

[0007] In an embodiment the plurality of polyhedron blocks is at least four blocks.

[0008] In an embodiment the adjacent blocks are in a face to face arrangement in the first configuration.

[0009] In an embodiment each block rotates about an axis of rotation that passes through its centre.

[0010] In an embodiment the all of the axes of rotation are either parallel or aligned.

[0011] In an embodiment the direction of rotation about the centres of each of adjacent block is in opposite directions.

[0012] In an embodiment the blocks are connected such that all the blocks simultaneously move within one or more parallel planes relative to other blocks in the same plane.

[0013] In an embodiment each block has at least one face abutting a face of another block in the first configuration and each block at least one face abutting a face of another block in the second configuration, wherein at least one pair of faces in the first configuration have swapped from being either face to face or not face to face to being not face to face or face to face, respectively, in the second configuration.

[0014] In an embodiment one set of faces move from an outside surface of the apparatus in the first configuration to be inside the apparatus in the second configuration.

[0015] In an embodiment another set of faces move in the first configuration, but remain on the outside surface of the apparatus in the second configuration.

[0016] In an embodiment a further set of faces move from inside the apparatus in the first configuration to be on an outside surface of the apparatus in the second configuration.

[0017] In an embodiment in each configuration there are at least two possible transformations, each of which is from a transverse orientation to each other, to another possible configuration.

[0018] In an embodiment the connections between adjacent blocks mirror each other.

[0019] In an embodiment the shape of adjacent blocks mirror each other.

[0020] In an embodiment the polyhedron blocks are cube shaped or cuboid.

[0021] In an embodiment the blocks are arranged into a lattice in the first configuration. In an embodiment the blocks are arranged into a lattice in the second configuration.

[0022] In an embodiment when in the first configuration the apparatus is a n x m x k parallelepiped, where n, m and k are all more than one.

[0023] In an embodiment n, m and k are the number of number of blocks along each side.

[0024] In an embodiment n, m and k are the relative dimensions of each side.

[0025] In an embodiment when in the second configuration the apparatus is of the same overall shape as it is in the first configuration.

[0026] In an embodiment the inside of the apparatus is hollow. Generally this occurs in n x m x k block configurations, where in n, m and k are at least three.

[0027] In an embodiment one or more of the blocks has an opening in a face of the or each block, where the opening leads into an internal cavity within the or each block.

[0028] In an embodiment the connections between blocks are each in different directions. In an embodiment the connections between blocks are each in a different one of the cardinal directions.

[0029] In an embodiment each of the connections are one of two types comprising: a type that constrains rotation of adjacent block to remain in one plane; or a type that constrains rotation of adjacent block to be sequentially in different orthogonal planes.

[0030] In an embodiment at least two of the connections are of different types.

[0031] In an embodiment the connection of a first block to a face of a second block is orthogonal to connections of other adjacent blocks to the face of the second block.

[0032] In an embodiment a corner block has three connections.

[0033] In an embodiment an edge block has four connections.

[0034] In an embodiment a non edge face block has five connections.

[0035] In an embodiment an inner block has six connections.

[0036] In an embodiment each connection is one of the following:

i) a two node connection on each of adjacent edges of connected blocks;

ii) a three node connection with each point being on an edge of a respective common corner on each of the connected blocks;

iii) a four node connection on each edge intersecting a plane passing through the centres of the connected blocks;

iv) a four node connection on each spaced apart edge of a pair of adjacent corners in each connected block;
v) a five node connection on each edge intersecting a respective plane passing through the centre of each connected block;  
vi) a six node connection on each edge intersecting a respective plane passing through the centre of each connected block;  
vii) an eight node connection on each edge of a pair on intersecting planes being equidistant from the centre of the respective connected blocks;  
viii) a pair of four node connections on each edge intersecting a respective one of a pair of parallel planes orthogonally equidistant from the respective centres of the connected blocks;  
ix) a resiliently stretchable connection between respective adjacent corners of face to face blocks.

In an embodiment the blocks retain their relative position but changing their relative orientation between configurations.

In an embodiment the blocks are cubic-shaped and comprise two different mirrored types and comprise two different polygon-shaped bases, while their connections towards the X, Y or Z axes are always preserved.

In an embodiment one of more of the connections are formed by a continuous loop through at least two nodes on each block. In an embodiment the loop is formed of a string nested within a groove within the connected blocks. In an embodiment the groove retains and or guides the string in place on the respective block.

According to the present invention there is provided a synchronised movement apparatus comprising at least three polyhedrons blocks, comprising a first polyhedron connected to a second polyhedron by a first connection and the second polyhedron is in turn connected to a third polyhedron by a second connection; wherein the each connection is configured to permit relative rotation of the connected polyhedrons about their respective centres.

According to the present invention there is provided a synchronised movement apparatus comprising at least four polyhedrons formed into a composite polyhedron in a first configuration, wherein the polyhedrons are connected such that they are collectively moveable so as to transform from the first configuration into a second configuration, such that each polyhedron has at least one face abutting a face of another polyhedron in the first configuration and each polyhedron has at least one face abutting a face of another polyhedron in the second configuration, wherein at least one pair of faces in the first configuration have swapped from being either face to face or not face to face to being not face to face or face to face, respectively, in the second configuration.

Preferably, each block comprises a base that carries a visual representation, such that when the blocks are properly arranged, the combination of the visual representations of each of the bases provides a distinct representation which represents a solution to a puzzle. In this way, the apparatus may be adapted to be a puzzle. The visual representation carried by each base may be identical. The visual representation may comprise colours or a combination of different colours to form a pattern.

The plurality of blocks may be made of the same or different types of material, such as wood, plastic, or metal. Magnets may be used to stabilise the faces by attracting them together.

Each or at least one of the plurality of blocks may comprise different colours, characteristics or images. In an embodiment the surface of each or at least one of the blocks may have different textures or characteristics.

The connections may be made of string, fishing line, rubber band, or elastic material to be strong enough and flexible enough to allow the game blocks to be simultaneously rotated by a user.

Each of the plurality of blocks or the plurality of the blocks collectively may be arranged to define the general shape of a three dimensional Platonic or Archimedean solid, or a truncated, stellated or rounded variation of these solids.

The plurality of blocks may be edible.

In an embodiment the apparatus comprises means for preventing rotation of the blocks about their centre.

Instead of a physical device, it is also envisaged that the apparatus may be implemented virtually in a computer game.

In an embodiment the apparatus may be simulated in a computing environment.

Also according to the present invention there is provided a game apparatus comprising a processor for simulating the apparatus as defined above and a display or displaying the simulated apparatus and an input for receiving instructions from a user to control the processor to simulate manipulation of the simulated apparatus.

In an embodiment the input is in the form of a finger or hand controller to receive simulated control of the blocks causing them to rotate about their centre.

The game apparatus may be implemented online and may be also programmed as a multi-player game so that players compete against one another to solve the puzzle within the shortest period of time. The game apparatus may also be implemented in a hand-held electronic gaming device.

According to the present invention there is provided a method of simulating an apparatus comprising using a computer processor to simulate a plurality of polyhedron blocks arranged in a first configuration, and simulate a connection between adjacent blocks that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration; and displaying the simulated blocks.

In an embodiment the method further comprises receiving an input from a user to simulate manipulation of the simulated apparatus.

According to the present invention there is provided a computer program comprising instructions stored on a computer readable medium in a non-transient manner, the instructions arranged to control a processor to simulate an apparatus by simulating a plurality of polyhedron blocks arranged in a first configuration, and simulating a connection between adjacent blocks that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration.

According to the present invention there is provided a connection between two polyhedrons comprising at least two points on one or more edges of a first one of the polyhedrons and at least two points on one or more edges of a second one of the polyhedrons, wherein the connection
allows the polyhedrons to rotate relative to each other such that each polyhedron rotates about a line passing through the centre point each polyhedron and a centre point of the respective set of at least two points on the one or more edges of the respective polyhedron.

[0068] According to the present invention there is provided a connection between two polyhedrons, where the polyhedrons are constrained to be face to face or move so as to be face to face, the connection comprising a joint at a corner of each polyhedron, wherein the connection allows the polyhedrons to rotate relative to each other such that each polyhedron rotates about a line passing through the centre point each polyhedron and the corner of the respective polyhedron.

[0069] According to the present invention there is provided a synchronised movement apparatus comprising at least eight cubes formed into a composite parallelepiped in one configuration, wherein the cubes are connected such that they are collectively moveable so as to deform from the composite parallelepiped in a second configuration and move to form another composite parallelepiped in a third configuration, where each cube rotates about its centre in a parallel or in-line orientation relative to an adjacent cube.

DESCRIPTION OF DRAWINGS

[0070] Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0071] FIG. 1 is a schematic isometric view of eight types of connection according to embodiments of the present invention;

[0072] FIG. 2A is a schematic isometric view of a pair of face to face blocks and nodes of connection along edges of the blocks for a three node connection according to an embodiment of the present invention;

[0073] FIG. 2B is a schematic isometric view of the pair of face to face blocks of FIG. 2A having each been rotated and showing the relative positions of the nodes of connection along edges of the blocks after the rotation;

[0074] FIG. 3A is a schematic isometric view of a pair of face to face blocks and nodes of connection along edges of the blocks for a four node connection;

[0075] FIG. 3B is a schematic isometric view of the pair of face to face blocks of FIG. 3A having each been rotated and showing the relative positions of the nodes of connection along edges of the blocks after the rotation;

[0076] FIG. 4A is a schematic isometric view of a pair of face to face blocks and nodes of connection along edges of the blocks for a six node connection;

[0077] FIG. 4B is a schematic isometric view of the pair of face to face blocks of FIG. 4A having each been rotated and showing the relative positions of the nodes of connection along edges of the blocks after the rotation;

[0078] FIG. 5 is a schematic isometric view of a lattice of blocks according to an embodiment of the present invention;

[0079] FIG. 6 is a schematic isometric view of four face to face blocks showing positions and directions of three node connections to adjacent blocks according to an embodiment of the present invention;

[0080] FIG. 7A is a schematic isometric view of a X & Y axis grid of blocks of FIG. 6 showing positions and directions of three node connections to adjacent blocks according to an embodiment of the present invention;

[0081] FIG. 7B is a schematic isometric view of a X & Z axis grid of blocks of FIG. 6 showing positions and directions of three node connections to adjacent blocks according to an embodiment of the present invention;

[0082] FIG. 7C is a schematic isometric view of a Y & Z axis grid of blocks of FIG. 6 showing positions and directions of three node connections to adjacent blocks according to an embodiment of the present invention;

[0083] FIG. 8A is a schematic isometric view of a four face to face front blocks and four rear blocks showing positions and directions of six point connections between adjacent blocks in the X-axis and three node connections in the Y & Z axes according to an embodiment of the present invention;

[0084] FIG. 8B is a set of schematic isometric views of a 3x3x3 lattice of blocks using the connection arrangement of FIG. 8A in which the lattice transforms to and from a first configuration and a fifth configuration via one of a second, third or fourth configuration;

[0085] FIG. 9A is a schematic isometric view of a four face to face front blocks and four rear blocks showing positions and directions of two sets of six node connections between adjacent blocks in the X & Y axes and three node connections in the Z-axis according to an embodiment of the present invention;

[0086] FIG. 9B is a set of schematic isometric views of a 3x3x3 lattice of blocks using the connection arrangement of FIG. 9A in which the lattice transforms sequentially through twelve configurations;

[0087] FIG. 10A is a schematic isometric view of a 2x2x2 lattice of blocks in a first configuration according to an embodiment of the present invention;

[0088] FIG. 10B is a schematic isometric view of the lattice of blocks of FIG. 10A in an interim configuration according to the present invention;

[0089] FIG. 10C is a schematic isometric views of the lattice of blocks of FIG. 10A transformed in to a second configuration;

[0090] FIG. 11 is a schematic isometric view of a 2x2x2 lattice of blocks of FIG. 6 in a first configuration showing the connections between the blocks according to the present invention;

[0091] FIG. 12 is a schematic isometric view of a 3x3x3 lattice of blocks of FIG. 6 in a first configuration showing the connections between the blocks according to the present invention;

[0092] FIG. 13 is a schematic isometric view of a set of configurations (A to G) between a pair of face to face blocks having a node of connection between a respective corner of each block according to an embodiment of the present invention; and

[0093] FIG. 14 is a schematic block diagram of a game apparatus according to an embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0094] In general terms, an embodiment of a synchronised movement apparatus comprises a plurality of polyhedron blocks able to be arranged in a first configuration. Adjacent blocks have a connection therebetween that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second
configuration. The connections between the blocks may be direction connections or indirection connections.

[0095] Referring to FIGS. 10A to 10C, there is shown an embodiment of an apparatus 100 according to the present invention comprising a 2x2x2 lattice of blocks 110, 120, 130 & 140 in a first configuration. In this embodiment each block is cube shaped and the lattice is collectively cube shaped. The blocks are connected together by for example a connection arrangement shown in FIG. 11, as will be described further below. For now, two of the connections 104A and 104B are shown. In this configuration the connections 104A and 104B are positioned adjacent each other. These connect the adjacent blocks so that they can fold relative to each other about the adjacent edge on which the respective connection 104A or 104B is located. Each block has cardinal axes extending from its centre. Each of these axes passes orthogonally through a face of the block. Adjacent blocks will have a common axis in this embodiment. These axes form the dashed centre lines shown and are also axes of rotation of the blocks.

[0096] The manner in which the blocks can rotate is limited due to the connections. For example the connection 104A between blocks 110 and 130 will allow them to rotate such that the adjacent faces part and rotate about the connection 104A. However they will not be able to part and rotate about the adjacent corners opposite the connection 104A because connection 104A prevents this.

[0097] The connections between the blocks in this embodiment allow the blocks 110 and 140 to rotate clockwise relative to blocks 120 and 130. In doing so, the lattice will transform into the interim configuration 100b shown in FIG. 10B. The transformation is limited by the connections. One of the limitations requires the blocks to move simultaneously relative to each other. Another limitation is that there is symmetry of movement about each connection. It can be seen that blocks 110 and 140, along with those blocks in-line in the Z-axis with these, have rotated 90 degrees. Blocks 120 and 130, along with the blocks in line with them in the Z-axis, have moved as well. If the user was holding block 130, or the line of blocks in the Z-axis including block 130, so that they are relatively stationary the remainder of the blocks have moved relative to this line of blocks.

[0098] It can be seen that a space 101 has opened between the lines of blocks. The blocks are in a general cross shape extending in the Z-axis.

[0099] Blocks 110 and 140 can continue to be rotated clockwise relative to blocks 120 and 130. The lattice will transform into the configuration 100c shown in FIG. 10C. It can be seen that blocks 110 and 140 along with those blocks in-line in the Z-axis with these have rotated a further 90 degrees. Blocks 120 and 130, along with the blocks in line with them in the Z-axis have moved again as well. If the user was still holding block 130, or the line of blocks in the Z-axis including block 130, so that they are relatively stationary the remainder of the blocks have again moved relative to this line of blocks.

[0100] It can be seen that the blocks have reformed into a cube shape, but they are in relatively different orientations even through they are in the same positions relative to each other. The connections 104A and 104B are now separated.

[0101] It can be seen that each block has at least one face abutting a face of another block in the first configuration 100 and each block has at least one face abutting a face of another block in the second configuration 100b. At least one pair of faces in the first configuration 100 have swapped from being either face to face or not face to face to being not face to face or face to face, respectively, in the second configuration 100b.

[0102] One set of faces moved from an outside surface of the apparatus in the first configuration 100 to be inside the apparatus in the second configuration 100b, for example face 142 moved from the outside to be inside. Another set of faces move between configurations, but remain on the outside surface of the apparatus in the second configuration, for example face 132 remains on the outside. Another set of faces move between configurations, but remain on the inside surface of the apparatus in the second configuration, for example face of block 110 having edge 112 remains on the inside. A further set of faces move from inside the apparatus in the first configuration 100 to be on an outside surface of the apparatus in the second configuration 100b, for example face 122 moved from the inside to be outside.

[0103] The apparatus may be manipulated again by moving the blocks relative to each other either in the reverse of the last move or another move that depends on the moves allowed by the connections.

[0104] FIG. 1 shows ways in which a continuous loop may be drawn around a block, such as a cube or a hexahedron. There are infinite ways to draw such a line, but only few cases may create a stable enough physical structure. The position of the continuous loop depends on a number of nodes which lie on the edges of the cube. A continuous groove is then created on the continuous loop in order to guide strings along two or more blocks.

[0105] More specifically, FIG. 1 shows some examples where the paths pass through two, three, four, five, six, or eight nodes. Those are the a-connection cubes, where a depends on the number nodes and how they are placed around the cube.

[0106] A 2-connection is represented by a string that goes through two nodes on each block on the same edge. This type of connection may also be represented by two blocks permanently connected on the same edge.

[0107] A 3-connection is represented by a string that goes through three nodes on each block (each one on a different edge, forming a triangular groove on each block) as shown in FIG. 1. This type of connection may also be represented by two blocks permanently connected on the same edge (this is when we assume that the nodes converge all towards the same corner becoming one node and providing a groove of length zero).

[0108] FIG. 2A shows the face of block A that contains the edge A1-A2 is matching with the face of block B that contains the edge B1-B2. The string follows the closed path A1-B2-B3-B1-A2-A3-A1. The next move, shown in FIG. 2B, allows the face of block A that contains the edge A1-A3 to match with the face of block B that contains the edge B1-B3. The new closed path now is A3-B1-B2-B3-A1-A2-A3. This movement continues through a total of three faces (for each block) in a circular fashion, and is then repeated. Similar movement may be achieved the opposite way too, always following the path as defined by the edges.

[0109] A 4a-connection is represented by a string that goes through four nodes on each block (one on a different edge, forming a square groove on each block) as shown in FIG. 1. FIG. 3A shows the face of block A that contains the edge A1-A2 is matching with the face of block B that contains the edge B1-B2. The string follows the closed path A1-B2-B3-
B4-B1-A2-A3-A4-A1. The next move, shown in FIG. 3B, allows the face of block A that contains the edge A1-A4 to match with the face of block B that contains the edge B1-B4. The new closed path now is A4-B1-B2-B3-B4-A1-A2-A3-A4. This movement continues through a total of four faces (for each block) in a circular fashion, and is then repeated. Similar movement may be achieved the opposite way too, always following the path as defined by the edges.

[0110] A 4b-connection is represented by a string that goes through four nodes on each block (one on a different edge, forming a parallelepiped groove on each block) as shown in FIG. 1. In this case, we may also simulate the connection by a wire connecting the two corners of the same block (such that, a sliding connector joins the two blocks through the two wires). Or, we may use instead two strings (which have the same length with the edge a cubic game block), such that each string connects a corner of the first block with a corner of the second block which is one edge further. It then behaves like a two mutually “swapping corner” connection.

[0111] A 5-connection is represented by a string that goes through five nodes on each block (one on a different edge, forming a pentagon groove on each block) as shown in FIG. 1.

[0112] A 6-connection is represented by a string that goes through six nodes on each block (each one on a different edge, forming a hexagon groove on each block) as shown in FIG. 1. FIG. 4A shows the face of block A that contains the edge A1-A2 is matching with the face of block B that contains the edge B1-B2. The string follows the closed path A1-B2-B3-B4-B5-B6-A1-A2-A3-A4-A5-A6. The next move, shown in FIG. 4C, allows the face of block A that contains the edge A1-A6 to match with the face of block B that contains the edge B1-B6. The new closed path now is A6-B1-B2-B3-B4-B5-B6-A1-A2-A3-A4-A5-A6. This movement continues through a total of six faces (for each block) in a circular fashion, and is then repeated. Similar movement may be achieved the opposite way too, always following the path as defined by the edges.

[0113] An 8-connection is represented by a string that goes through eight four nodes on each block (one on a different edge, forming an octagon groove on each block) as shown in FIG. 1.

[0114] In a similar fashion we may have many types of a-connections, and the choice of the number and the position of nodes depends on our needs.

[0115] The stability of the structure is an important feature, as the neighboring blocks are the ones which together with the connections provide a symmetric balance. Moreover, at least three axis connections and at most six axis connections per block are required for stability that combines a total of n times m times k blocks, where n, m, and k are all greater than one. For example, a game block which is in the centre of a 3x3x3 cube (which is made of a total of 27 cubic game blocks) is surrounded by six game blocks. Thus, it is connected with six game blocks. Similarly, a block which resides at the corner of the 3x3x3 cube, is connected with three other game blocks. The nomok designs where n, m, k, are all greater than two, are more stable in general.

[0116] Since this is a three dimensional apparatus, and in order to fully utilise the symmetric properties of the design, it is preferable that each axis shares the same type of a-connection. That is: on the X-axis, all of the connections should be a1-connections; on the Y-axis, all of the connections should be a2-connections; and on the Z-axis, all of the connections should be a3-connections; where a1, a2, and a3 are not necessarily different.

[0117] Generally speaking, an a-connection is every possible path around a block which may be connected via a string to a mirrored path of another block.

[0118] FIG. 5 shows a lattice representation of how the cubic blocks may be spread in the three dimensions to create an nxmxk composite cube, where n, m, and k are all greater than one. The lattice may be expanded through all three different three dimensional directions to create larger cubes or parallelepipeds.

[0119] FIG. 6 categorises the blocks in four types A, B, C, D, revealing the potential connections with each other when all of the connections of the nxmxk cube are 3-connections. That is, on the X-axis, all of the connections should be 3-connections, on the Y-axis, all of the connections should be 3-connections, and on the Z-axis, all of the connections should be 3-connections. Feasible connections for the case where we only have 3-connections are as shown by the numbered arrows in FIG. 4A that can connect the points with matching numbered arrows, namely: (i) A1 and C1, (ii) A2 and B2, (iii) A3 and B3, (iv) A4 and C4, (v) A5 and D5, (vi) A6 and D6, (vii) B1 and D1, (viii) B4 and D4, (ix) B5 and C5, (x) B6 and C6, (xi) C2 and D2, and (xii) C3 and D3.

[0120] FIGS. 7A, 7B, and 7C show the way the blocks of FIG. 6 are connected in the XY-plane, XZ-plane, and YZ-plane respectively. This model has a total of five states, two of which can move in all three axes, and three of which can move through two axes. FIG. 5E represents the moves required to reach all five states for the case where we have a 3x3x3 cube with the connections described above (the number of states are exactly the same for any n mxk cube or parallelepiped). As all the blocks can simultaneously rotate with respect to any of the three dimensional axes, the apparatus’ movement does not resemble anything previously known.

[0121] FIG. 11 shows the blocks of FIG. 6 connected in a 2x2x2 lattice to form a composite cube of two blocks in each dimension.

[0122] FIG. 12 shows the blocks of FIG. 6 connected in a 3x3x3 lattice to form a composite cube of three blocks in each dimension.

[0123] FIG. 8A represents the case where we have a 2x2x2 cube, such that on the X-axis, all of the connections should be 6-connections, on the Y-axis, all of the connections should be 3-connections, and on the Z-axis, all of the connections should be 3-connections. This model has a total of six states, all of which can move through two axes. An extra property is that this model’s game block blocks can be completely inverted, causing this apparatus to be able to achieve a completely different theme in all six sides which was hidden.

[0124] FIG. 8B represents the moves required to reached all six states for the case where we have a 3x3x3 cube with the connections described above in FIG. 8A. That is, on the X-axis, all of the connections should be 6-connections, on the Y-axis, all of the connections should be 3-connections, and on the Z-axis, all of the connections should be 3-connections. The number of states are the same for any n mxk cube or parallelepiped. Note that, for example, the state (V) in FIG. 8B could be a fully invertible version of the state (I) (i.e. the outer corners of the apparatus in state (I) become hidden when state (V) is achieved).
FIG. 9A represents the case where we have a 2x2x2 cube, such that on the X-axis, all of the connections should be 6-connections, on the Y-axis, all of the connections should be 6-connections, and on the Z-axis, all of the connections should be 3-connections. This model has a total of twelve states, all of which can move through two axes. An extra property is that this model's blocks can be completely inverted, causing this apparatus to be able to achieve a completely different theme in all six sides which was hidden.

FIG. 9B represents the moves required to reach all twelve states for the case where we have a 3x3x3 cube with the connections described above. That is, on the X-axis, all of the connections should be 6-connections, on the Y-axis, all of the connections should be 6-connections, and on the Z-axis, all of the connections should be 3-connections. Again the number of states are the same for any nxnxk cube or parallelepped or hexahedron with similar properties but different number of states and possibilities of movement through the three axes X, Y, and Z.

Referring to FIG. 13 there is shown an alternative 3-connection (referred to as a 3alt-connection) in which the 3-connection is at an adjacent corner of each block and limits the relative movement to be rotation only through 90 degrees of rotation and the rotation is about only one of the abutting edges which extend from the connection. There are two edges which extend from the connection, so that the 3alt-connection is limited to provide hinge-type rotation about the edge in 2 orthogonal directions, but not allow simultaneous rotation in 2 orthogonal directions, such that the rotation progresses through steps A to F in FIG. 13. In comparison a normal 3-type connection can allow simultaneous rotation in 2 orthogonal directions.

The 3alt-connection can be achieved by using a small "pipe" permanently attached to each of the blocks which are connected through the pipes. The pipes constrain the movement so that no other free movement is allowed. It is noted that moving from A to C, from C to E, and from E to G, requires a single "snapping" movement (perhaps with internal springs) to avoid any momentum that could be gained in figures B, D, and F, and which could result in unwanted diagonal movement.

To play the apparatus, a user holds the apparatus in his hand and manipulates the apparatus, for example by directional rotating of one block, to cause a simultaneous rotation of the rest of the blocks, all of which are connected to the first block. More than one block may be used as a handle provided their rotation is consistent and compatible to the intended rotation of the first block. The position of each of the blocks with respect to the all of the other blocks remains the same, but their orientation changes with respect to one of the axis X, Y, or Z, depending on the axis chosen.

With this arrangement, a simple and yet challenging puzzle with interesting mechanics may be created, for example if the faces of the blocks are configured to carry a certain image and a user rotates the blocks to form a predetermined larger image which combines faces of more than one blocks to solve a puzzle. Through playing the puzzle, a player can explore the relationship between three-dimensional space and two-dimensional planar structures, the interrelation of inner and outer space characteristics, their specific features and regularities. Such a puzzle also has a considerably wide range of choices between possible step variations so that the player can entertain himself/herself while the puzzle maintains the player's attention and improves the player's mechanical aptitude simultaneously. The player's hand and eye coordination skills can be improved and the puzzle supports a kinaesthetic learning process. As a result, such a puzzle is not only educational but also fun.

It can also be appreciated that in the course of playing, the solution of the puzzle is altered by rearranging the blocks, through any sequence of steps. Following this, the goal of the game may lie in arriving at the initial regular specific pattern of the blocks, possibly and preferably within the shortest period of time, i.e. by performing, out of a large number of variations, the shortest sequence of steps through which all blocks are moved back into their initial position. Arriving at a pre-determined specific pattern of the blocks may prove to be a hard task despite the fact that handling the puzzle seems, at least at first instance, to be very easy, resulting in a challenging puzzle.

While handling the apparatus with an aim of solving the puzzle, the player is confronted with questions regarding the relationship between a three-dimensional space and planer structures contained and moved therein. Problems of interrelating the senses of rotation, the reversioning of coordinate systems, and the terms of "outside" and "inside" will gradually become more and more apparent to regular and enthusiastic users of the puzzle.

The described embodiments should not be construed as limiting. For example, the apparatus may be configured as a puzzle, toy or generally a game apparatus. For example, there is nothing to solve but a user simply rotates the game or game blocks for fun or amusement, or to look at different representations carried by the faces of the game blocks. The described embodiment uses a cube as a Platonic solid, but other Platonic solids may be used such as Tetrahedron, Octahedron, Dodecahedron, and Icosahedron, as long as they are connected in at least three ways and at most six ways with other game blocks.

Some connections may permit other movements, or greater freedom of movement, when the blocks are in a particular configuration. For example when there are 4 adjacent 3-connections and the connections are between adjacent planes of blocks with no other blocking connections between the planes of blocks, then the planes of blocks may rotate relative to each other about the connections. Generally the blocks are captured in the composite form, however in some configurations the blocks may be free to move out of the composite form, particularly in a transition, where the blocks are spaced apart.

In an embodiment the faces of the blocks may be marked with aesthetically appealing representations, for example, symbols, sections or parts of graphic pictures which, when the game pieces are arranged properly, show a specific, pre-determined characteristic pattern. To solve such a puzzle, the user may need to rely on his memory to solve the puzzle. This is because when the user causes a game block to rotate, some faces will hide, while some new ones will be revealed, depending on the way the game blocks are connected. Thus, the user may need to rely on memory in
order to know which other game blocks to move to solve the puzzle as determined by a predetermined pattern on the inner and/or outer surfaces.

[0137] Magnetic material may be used on the blocks for enhanced stability and to assist in the movement to snap into a correct position, but the main forces keeping the puzzle together are the a-connections.

[0138] More than one layer of strings may be used in parallel to enhance stability.

[0139] In an embodiment one or more of the blocks or faces may be transparent or translucent to allow view inside the apparatus. Other blocks or faces may be opaque. One or more blocks may have a light reflecting mirror on a face or internal to reflect light inside the apparatus.

[0140] The apparatus may be illuminated for example, by including a battery to power lights. The lights may be visible to the human eye so that it enhances the playing experience at night. Also, it is envisaged that the lights may be invisible to the human eye, such as infra-red, which may be observed through night vision devices. The blocks may be made of fluorescent materials which emit light, in the visible or invisible range (for the latter, special equipment like the night vision device might be needed). Further, the blocks may comprise electrical contacts which corresponds to electrical contacts on another block such that when the corresponding electrical contacts made contact, a specific visual image or representation is displayed at the base of the respective blocks, for example, to signify to the user that adjacent blocks are correct (or not).

[0141] Each block may be made of wood, plastic, metal or any other solid material. Each block may also be hollow or without a base (for example, when the puzzle uses the inner surfaces as a guide to solve the puzzle as explained above instead of the base).

[0142] An opening to one or more hollows may be provided with a door that opens or closes automatically depending on one or more of the following:

1) the orientation of the apparatus relative to gravity;
2) the orientation of the block relative to gravity;
3) the manner of orientation of one or more adjacent blocks.

[0143] An object, such as a bead, may be captured inside a hollow and an object of use of the apparatus is to get the object outside of the apparatus or to another part of the apparatus.

[0144] The corners of each block may also be rounded, stellated or truncated for decoration reasons, or to allow free movement or to block movement. It is also envisaged that the blocks of the puzzle apparatus may be made of different materials so that at least one or some of the blocks have a different weight or mass compared to the rest. This creates an imbalanced centre of gravity which creates a more challenging or puzzle apparatus.

[0145] It is also envisaged that each block may be made of something edible such as chocolate, cheese, biscuits or some type of sweet. The puzzle may thus be marketed as a "puzzle-snack", perhaps encouraging the user to solve the puzzle before consuming the snack.

[0146] In certain embodiments of the invention, the string may simultaneously serve as a symbol, i.e., as means of making the blocks, for example, by coloring or otherwise, so that they will become distinguishable from each other. When designed so, the function of retaining is, at least to a certain extent, substantially hidden or even disguised, so that such embodiments of the invention are made even more "puzzling".

[0150] Each of the blocks may also be replaced by another puzzle adding more degrees of freedom. For example, by replacing each cubic block by a 2x2 Rubik's Cube, a simultaneous rotation of the half parts of the 2x2 Rubik's Cube blocks will allow the shifting of the a-connections, making the puzzle more challenging.

[0151] The same concept may be used with any other shapes for the blocks which fall into the same type of topological transformation, including bandaging of pieces, stellation of pieces, and truncation of pieces, and addition of holes, provided that the concept of the mechanism is preserved, main concept of mechanism being that all of the blocks move according to their a-connections (as described above) along all three dimensional axes.

[0152] The apparatus may be used for educational, civil, engineering, aviation, automobile and entertainment purposes. The apparatus may also be adapted as part of a smart lock in a security system, for example, when the apparatus is configured as a puzzle, when the puzzle is solved, this unlocks the security system guarding a door, for example.

[0153] The apparatus may also have other applications, for example as a dice. The surfaces of the blocks are provided with dots depicting numbers of a dice or the actual numbers and the apparatus may be rolled to determine what number or number combinations are visible.

[0154] It is also envisaged that the apparatus may be implemented virtually or electronically such as for a computer game. To do this the apparatus may be simulated in a computing environment.

[0155] An example would be to offer the apparatus in virtual form as a 3-D representation on the internet so that a player can use some form of controller, such as a mouse or joystick to manipulate or control the movement of the virtual housing so as to rotate the virtual blocks. The puzzle may also be implemented as a multi-player game where two or more players compete with each other to solve the puzzle within the shortest period of time. It is also envisaged that this invention may be adapted to be a hand-held electronic gaming device, where the apparatus and the blocks are represented electronically or virtually. The gaming device may then have sensors configured to sense the directional movement of device as manipulated by the user's hands to rotate the virtual blocks according to the detected directional movement to play the game or solve the puzzle.

[0156] Further, with touch-screen technology becoming more widespread, it is also envisaged that a player may control the movement of the virtual housing by touching the screen of the hand-held gaming device programmed with the virtual gaming apparatus. The hand-held gaming device may be a mobile phone, PDA, tablet computer or any mobile gaming device.

[0157] The game apparatus may be implemented online and may be also programmed as a multi-player game so that players compete against one another to solve the puzzle within the shortest period of time.

[0158] As shown in FIG. 14, in an embodiment a game apparatus 1000 comprises one or more processors 1002 for simulating the synchronized movement apparatus, a display or displaying the simulated apparatus, and an input for receiving instructions from a user to control the processor to simulate manipulation of the simulated apparatus.
The processor(s) 1002 are able to receive an external input from input device 1008, which may be for example a joystick, keyboard or touch screen. The processor(s) 1002 are able to provide an output in the form of a graphic display of the simulated apparatus on a video display device 1010. The processor 1002 is controlled by instructions in the form of one or more computer programs stored on non-transient storage medium, such as a hard drive, flash memory, CD, DVD etc. to perform the function of acting as an electronic or virtual form of the apparatus described above.

According to the present invention there is provided a method of simulating a synchronised movement apparatus comprising a computer processor to simulate a plurality of polyhedron blocks arranged in a first configuration, and simulate a connection between adjacent blocks that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration; and displaying the simulated blocks.

Each step in the method may be preformed by a computing module configured to perform the respective steps. Each computing module may take the form of a computing module programmed with a subroutine or self-contained executable file. Each module may be executed on a single processor or a plurality of processors.

In an embodiment the method further comprises receiving an input from a user to simulate manipulation of the simulated apparatus.

According to the present invention there is provided a computer program comprising instructions stored on a computer readable medium 1004 in a non-transient manner, such as a hard disk drive, flash memory, CD, DVD etc. The instructions are arranged to be read in to computer memory 1006 and to control a processor to simulate a synchronised movement apparatus by simulating a plurality of polyhedron blocks arranged in a first configuration, and simulating a connection between adjacent blocks that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration.

Modifications may be made to the present invention within the context of that described and shown in the drawings. Such modications are intended to form part of the invention described in this specification.

1. A synchronised movement apparatus comprising a plurality of polyhedron blocks arranged in a first configuration, wherein adjacent blocks have a connection therebetween that allows symmetrical rotation of the adjacent blocks relative to each other so as to transform the arrangement of blocks into a second configuration.

2. A synchronised movement apparatus comprising at least three polyhedron blocks, comprising a first polyhedron connected to a second polyhedron by a first connection and the second polyhedron is in turn connected to a third polyhedron by a second connection; wherein the connection is configured to permit relative rotation of the connected polyhedrons about their respective centres.

3. A synchronised movement apparatus comprising at least four polyhedrons formed into a composite polyhedron in a first configuration, wherein the polyhedrons are connected such that they are collectively moveable so as to transform from the first configuration into a second configuration, such that each polyhedron has at least one face abutting a face of another polyhedron in the first configuration and each polyhedron has at least one face abutting a face of another polyhedron in the second configuration, wherein at least one pair of faces in the first configuration have swapped from being either face to face or not face to face to being not face to face or face to face, respectively, in the second configuration.

4. An apparatus as claimed in claim 1, wherein the adjacent blocks are in a face to face arrangement in the first configuration.

5. An apparatus as claimed in claim 1, wherein each block rotates about an axis of rotation that passes through its centre.

6. An apparatus as claimed in claim 1, wherein the all of the axes of rotation are either parallel or aligned.

7. An apparatus as claimed in claim 1, wherein the blocks are connected such that all the blocks simultaneously move within one or more parallel planes relative to other blocks in the same plane.

8. An apparatus as claimed in claim 1, wherein each block has at least one face abutting a face of another block in the first configuration and each block has at least one face abutting a face of another block in the second configuration, wherein at least one pair of faces in the first configuration have swapped from being either face to face or not face to face to being not face to face or face to face, respectively, in the second configuration.

9. An apparatus as claimed in claim 1, wherein one set of faces move from an outside surface of the apparatus in the first configuration to be inside the apparatus in the second configuration.

10. An apparatus as claimed in claim 9, wherein another set of faces move in the first configuration, but remain on the outside surface of the apparatus in the second configuration.

11. An apparatus as claimed in claim 10, wherein a further set of faces move from inside the apparatus in the first configuration to be on an outside surface of the apparatus in the second configuration.

12. An apparatus as claimed in claim 1, wherein each configuration there are at least two possible transformations, each of which is from a transverse orientation to each other, to another possible configuration.

13. An apparatus as claimed in claim 1, wherein the connections between adjacent blocks mirror each other.

14. An apparatus as claimed in claim 1, wherein the shape of adjacent blocks mirror each other.

15. An apparatus as claimed in claim 1, wherein the polyhedrons blocks are cube shaped or cuboid.

16. An apparatus as claimed in claim 1, wherein the blocks are arranged into a lattice in the first configuration.

17. An apparatus as claimed in claim 1, wherein the blocks are arranged into a lattice in the second configuration.

18. An apparatus as claimed in claim 1, wherein the inside of the apparatus is hollow.

19. An apparatus as claimed in claim 1, wherein one or more of the blocks has an opening in a face of the or each block, where the opening leads into an internal cavity within the or each block.

20. An apparatus as claimed in claim 1, wherein the connections between blocks are each in different directions.

21. An apparatus as claimed in claim 1, wherein each of the connections are one of two types comprising: a type that constrains rotation of adjacent block to remain in one plane; or a type that constrains rotation of adjacent block to be sequentially in different orthogonal planes.
22. An apparatus as claimed in claim 1, wherein at least two of the connections are of different types.

23. An apparatus as claimed in claim 1, wherein the connection of a first block to a face of a second block is orthogonal to connections of other adjacent blocks to the face of the second block.

24. An apparatus as claimed in claim 1, wherein each connection is one of the following:
   i) a two node connection on each of adjacent edges of connected blocks;
   ii) a three node connection with each point being on an edge of a respective common corner on each of the connected blocks;
   iii) a four node connection on each edge intersecting a plane passing through the centres of the connected blocks;
   iv) a four node connection on each spaced apart edge of a pair of adjacent corners in each connected block;
   v) a five node connection on each edge intersecting a respective plane passing through the centre of each connected block;
   vi) a six node connection on each edge intersecting a respective plane passing through the centre of each connected block;
   vii) an eight node connection on each edge of a pair on intersecting planes being equidistant from the centre of the respective connected blocks;
   viii) a pair of four node connections on each edge intersecting a respective one of a pair of parallel planes orthogonally equidistant from the respective centres of the connected blocks;
   ix) a resiliently stretchable connection between respective adjacent corners of face to face blocks.

25. An apparatus as claimed in claim 1, wherein the blocks retain their relative position but change their relative orientation between configurations.

26. An apparatus as claimed in claim 1, wherein one of more of the connections are formed by a continuous loop through at least two nodes on each block.

27. An apparatus as claimed in claim 26, wherein the loop is formed of a string nested within a groove within the connected blocks.

28. An apparatus as claimed in claim 27, wherein the groove retains and or guides the string in place on the respective block.

29. A game apparatus comprising a processor for simulating the apparatus as of claim 1 and a display or displaying the simulated apparatus and an input for receiving instructions from a user to control the processor to simulate manipulation of the simulated apparatus.

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