JOHNSON SOLIDS

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I like lists – in fact, I love lists. I like lists of words, such as the chemical elements, the days of the week, the months of the year, the letters of the Greek alphabet, the countries of the world, US state capitals, Oscar-winning films, the names of the stations on London’s Underground railway, the complete discography of Elvis Presley - I could go on. And as many Word Ways readers will be aware, I like transposing items from those lists.

I recently came across a list of terms which I’d not seen before, and I’m sure those terms haven’t been mentioned in Word Ways. (Someone tell me if I’m wrong.) There are a series of solid geometrical objects called the Johnson Solids, and there are precisely 92 of them, and each one has a name.

Before I get into their 92 names, some background information on these solids may be of interest. In 1966, US mathematician Dr Norman Johnson presented an article in the Canadian Mathematical Journal, in which he described the set of three-dimensional solids whose faces are a mixture of triangles, squares, pentagons, hexagons, octagons, and decagons. Three constraints applied to the solids: (1) all their edges must be the same length, (2) the faces must be regular, and (3) there can be no dimples in their surfaces. The technical term for such solids is irregular convex polyhedra. Some of them are complicated, with more than 50 faces. Johnson thought that there were 92 such solids, a result not mathematically proved until 3 years later. They are now known as the Johnson solids.

According to www.orchidpalms.com/polyhedra/johnson/johnson.html, Johnson gave each of the 92 polyhedra a unique name. In a communication dated December 2004, Dr Johnson states “when I was investigating regular-faced solids in the early 1960s, there were no established names even for many of the obvious ones, except for pyramids and bipyramids. So I invented terms like cupola and rotunda and devised other terminology (augmented, diminished, elongated, etc.) that covered all but the eight or nine anomalous figures at the end of my list, which got their own descriptive names.”

The names of the 92 solids are a mixture of familiar looking words and many splendidly exotic words, as will be seen from the full list below.

<table>
<thead>
<tr>
<th>Johnson Solid names</th>
<th>Johnson Solid names</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 square pyramid</td>
<td>47 gyroelongated pentagonal cupolarotunda</td>
</tr>
<tr>
<td>2 pentagonal pyramid</td>
<td>48 gyroelongated pentagonal birotunda</td>
</tr>
<tr>
<td>3 triangular cupola</td>
<td>49 augmented triangular prism</td>
</tr>
<tr>
<td>4 square cupola</td>
<td>50 blaungmented triangular prism</td>
</tr>
<tr>
<td>5 pentagonal cupola</td>
<td>51 triaugmented triangular prism</td>
</tr>
<tr>
<td>6 pentagonal rotunda</td>
<td>52 augmented pentagonal prism</td>
</tr>
<tr>
<td>7 elongated triangular pyramid</td>
<td>53 blaungmented pentagonal prism</td>
</tr>
<tr>
<td>8 elongated square pyramid</td>
<td>54 augmented hexagonal prism</td>
</tr>
<tr>
<td>9 elongated pentagonal pyramid</td>
<td>55 parablauaugmented hexagonal prism</td>
</tr>
<tr>
<td>10 gyroelongated square pyramid</td>
<td>56 metabiaugmented hexagonal prism</td>
</tr>
<tr>
<td>11 gyroelongated pentagonal pyramid</td>
<td>57 triaugmented hexagonal prism</td>
</tr>
<tr>
<td>12 triangular dipyramid</td>
<td>58 augmented dodecahedron</td>
</tr>
<tr>
<td>13 pentagonal dipyramid</td>
<td>59 parablauaugmented dodecahedron</td>
</tr>
<tr>
<td>14 elongated triangular dipyramid</td>
<td>60 metabiaugmented dodecahedron</td>
</tr>
<tr>
<td>15 elongated square dipyramid</td>
<td>61 triaugmented dodecahedron</td>
</tr>
<tr>
<td>16 elongated pentagonal dipyramid</td>
<td>62 metabidiminished icosahedron</td>
</tr>
<tr>
<td>17 gyroelongated square dipyramid</td>
<td>63 tridiminished icosahedron</td>
</tr>
<tr>
<td>18 elongated triangular cupola</td>
<td>64 augmented tridiminished icosahedron</td>
</tr>
<tr>
<td>19 elongated square cupola</td>
<td>65 augmented truncated tetrahedron</td>
</tr>
<tr>
<td>20 elongated pentagonal cupola</td>
<td>66 augmented truncated cube</td>
</tr>
<tr>
<td>21 elongated pentagonal rotunda</td>
<td>67 blaungmented truncated cube</td>
</tr>
<tr>
<td>22 gyroelongated triangular cupola</td>
<td>68 augmented truncated dodecahedron</td>
</tr>
<tr>
<td>23 gyroelongated square cupola</td>
<td>69 parablauaugmented truncated dodecahedron</td>
</tr>
<tr>
<td>24 gyroelongated pentagonal cupola</td>
<td>70 metabiaugmented truncated dodecahedron</td>
</tr>
<tr>
<td>25 gyroelongated pentagonal rotunda</td>
<td>71 triaugmented truncated dodecahedron</td>
</tr>
<tr>
<td>26 gyrobiastilgum</td>
<td>72 gyrate rhombicosidodecahedron</td>
</tr>
</tbody>
</table>

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Okay, that's the list of 92 terms. Now, what about transpositions, transdeletions and transadditions? Given the length of the 92 names, it's not surprising there aren't any transpositions or single-letter transadditions of any of the names. There appear to be just two single-letter transdeletions, both pretty obscure.

Square pyramid can have the letter P deleted, and the remaining letters transposed to Marquis de Ray. While this name comes up in internet searches, the correct spelling of the name seems to be Marquis de Rays. Charles Marie Bonaventure du Breil, Marquis de Rays (1832-1893) was a French nobleman who had ambitions of starting a great French colony in the South Pacific. He led four European expeditions to establish colonies in a place he called New France which is the island now referred to as New Ireland in the Bismarck Archipelago of present day Papua New Guinea.

Square cupola can have the letter U deleted, and the remaining letters transposed to Copal square. This is the name given to a focal plane shutter used in many cameras, and was first manufactured in the 1960s by the Japanese company Nidec Copal.

Things get a little easier if we look at transpositions, transdeletions and transadditions of the 53 component words in the 92 terms, rather than at the multi-word terms.

For single-letter transdeletions, the 15 best ones are:

- antiprism misprint (W3)
- augmented unteamed (W3)
- bicupola aboulic (W3)
- bigyrate bragite (W2)
- birotunda duration (W3)
- elongated engaoled (W2)
- icosahedron endorachis (W2)
- metagyrate tetragramy (W2)
- orthobicupola couirophobia (Wikipedia: a fear of clowns)
- pentagonal pantaleon (W3)
- pyramid myriad (W3)
- triangular Tragulina (W3)
- triaugmented deuterating (W3)
- trigyrate tertiary (W3)
- truncated underact (W3)

For transpositions, the 9 best ones are:

- antiprism Saint-Prim (Wikipedia: Saint-Prim is a commune in the Isère department in south-eastern France)
- bigyrate Tiger Bay (Wikipedia: Tiger Bay is the local name for an area of Cardiff which covers Butetown and Cardiff)
Docks
birotunda turbinado (W3)
cupola copula (W3)
gyrate geraty (W2)
prism prims (W3)
rotunda tandour (W3)
snub buns (W3)
truncated reductant (W3)

And for single-letter transadditions, the 10 best ones are:

bicupola pubollia (W2)
bigyrate betraying (W3)
birotunda obdurating (W3)
dipyrism pyramidoid (OED)
disphenoid hypnoised (W2 has the -ize infinitive form)
elongated delegation (W3)
gyrade tragedy (W3)
pyramid myriapod (W3)
rotunda untoward (W3)
triangular granularity (W3)

Footnote: Pictures of all the Johnson solids are online at mathworld.wolfram.com/JohnsonSolid.html. Much more descriptive information about the Johnson solids can be found on the internet. Wikipedia's article on the Johnson solids provides a good start, but there are many more increasingly esoteric webpages on other websites.

A FRENCH FRIVOLITY

Charlemagne et ses douze Pairs contemplant avec dépit les barques de l'invasion normande.
Où sont les 12 Pairs?