Bridging XYZ and IVM Volumetric Accounting Systems with the Square Root of 9/8

by Kirby Urner
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Students acquainted with the Concentric Hierarchy, an arrangement of nested polyhedra in *Synergetics* by R. Buckminster Fuller (Macmillan, 1979), may nevertheless be unclear on where the square root of 9/8 comes in as a "conversion factor" between XYZ cube-based volumes and IVM tetrahedron-based volumes.

The XYZ scaffolding is familiar to us all from school. The IVM is what Alexander Graham Bell studied as "kites" and is the space frame correlating with the CCP and/or FCC sphere packing arrangement. Fuller dubbed this scaffolding the "isotropic vector matrix" or IVM for short.

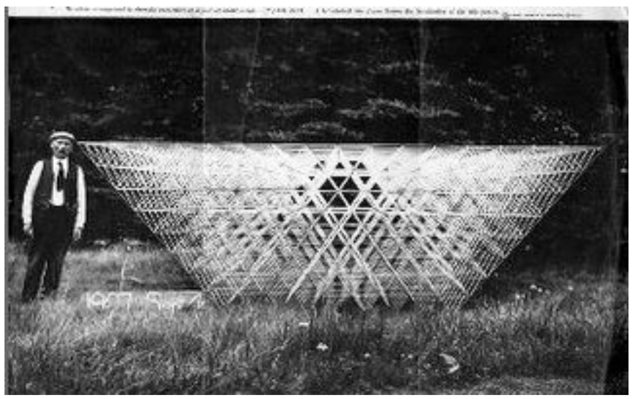


Fig 1: Alexander Graham Bell with Kite

Starting with unit radius spheres, we see four of them tightly packed define a tetrahedron of six edges D where D is a sphere diameter of 2R. The tetrahedron of edges D is the unit volume of Synergetics, wheres if we assume R=1, then a cube of edges R is the XYZ unit of volume.

If one pours water from an R to the 3rd power cube into a tetrahedron of edges D, some of the water will over flow because the cube has a volume of the square root of 9/8, or 1.06066 compared to the tetrahedron. This, then, becomes a conversion constant, for taking XYZ volumes to IVM and vice versa. [1]

To make this mathematics easy to visualize, I contextualize it in a science fiction story about Martians coming to Earth and working on a collaborative project: a dam across a canyon. Their unit for pouring concrete is 0.9428 smaller than the Earthling unit.

In calling the mathematics built on tetra-volume accounting "Martian Math", I help open the mental space for something new, from a different culture. Wittgenstein employs the same trick with "tribes" in his Investigations into the Foundations of Mathematics. [2]

So what is this "concentric hierarchy" all about? Many more whole numbers arise with the tetrahedron as our new unit of volume. These ratios are not news, however a strong rationale for using a tetrahedron in this way was not widely available until the 1970s, with the publication of *Synergetics* by R. B. Fuller.

The tabulation on the following page gives some idea of its IVM volumetric accounting:

Shape	Volume	A	B	T
A module	1/24	1	0	0
B module	1/24	0	1	0
T module	1/24	0	0	1
MITE	1/8	2	1	0
Tetrahedron	1	24	0	0
Coupler	1	16	8	0
Duo-Tet Cube	3	48	24	0
Octahedron	4	48	48	0
Rhombic Triacontahedron	5	0	0	120
Rhombic Dodecahedron	6	96	48	0
Cuboctahedron	20	336	144	0
2F Cube	24	384	192	0

Fig 2: From Wikipedia: Synergetics [3]

The tetrahedron, with its own dual, anchors a duo-tet cube of volume 3. The dual of said cube, with edges crossing mid-way, is the octahedron of volume 4, and those two, cube and dual, combine to give the rhombic dodecahedron (RD) of volume 6.

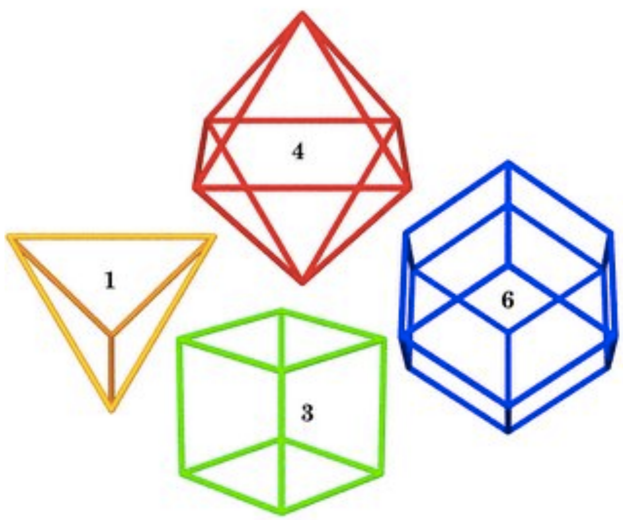


Fig 3: Whole Number Volumes

A rhombic triacontahedron (RT) of volume 7.5 inter-weaves with the RD of volume 6. Scaled down by 2/3, the 7.5 RT becomes the volume 5 RT of 120 T modules. Its radius is 0.9994 that of an IVM sphere encasing RT of radius 1 and 120 E modules.

The T and E modules are extremely close in volume, a fact over which Fuller lavished considerable attention. [4]

David Koski will be talking about how phi-scaled Synergetics modules, the T, E, S and others, may be used to both assemble and account the tetra-volumes of various additional familiar shapes.

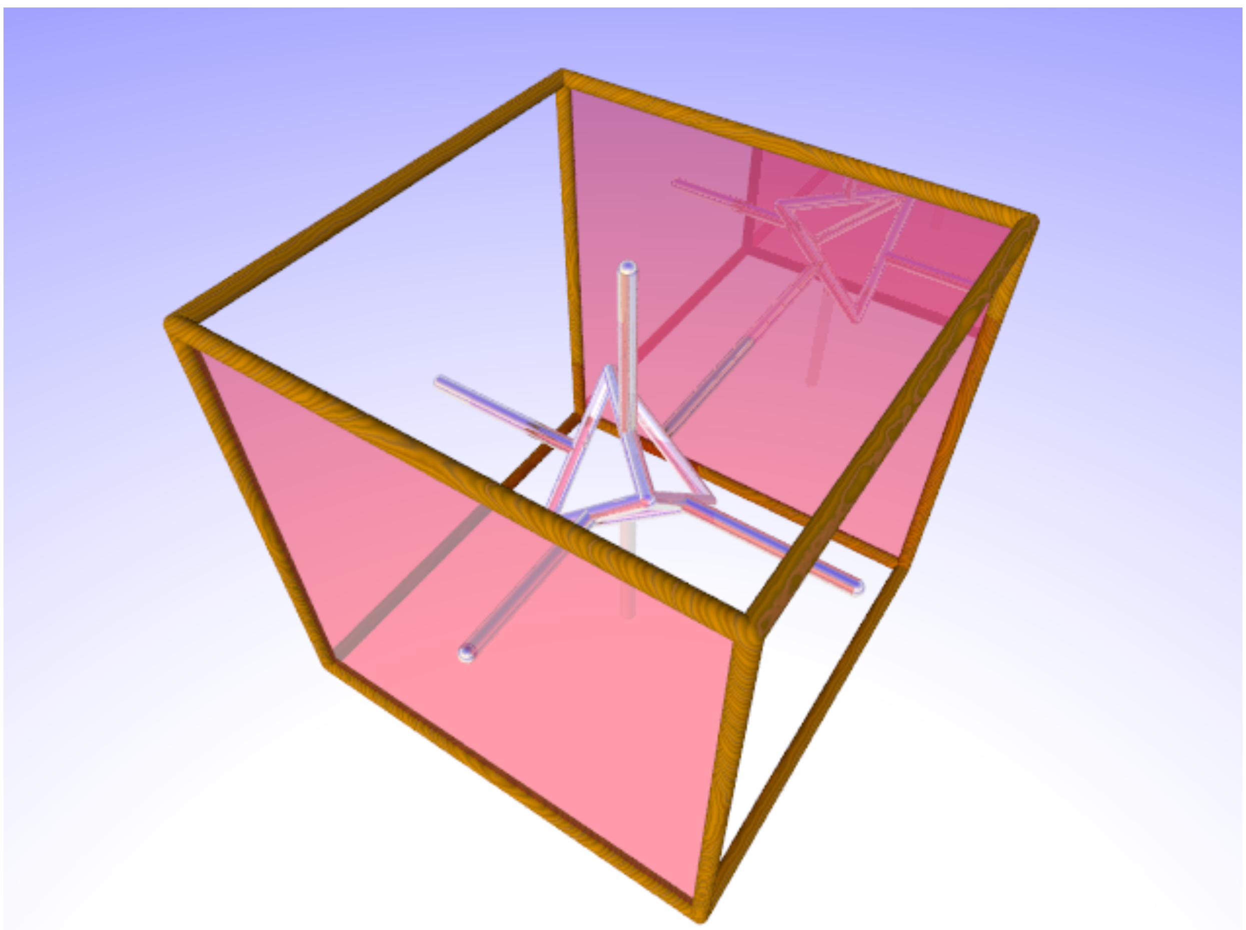
End Notes

[1] Early web-published writing on the Synergetics Constant (S3) by Robert Gray:
http://www.rwgrayprojects.com/rbfnotes/VolConstant/VolConstant.html

[2] my background is in philosophy with my undergraduate thesis at Princeton entitled *Some Thoughts on the Philosophy of Ludwig Wittgenstein*, 1980.

[3] http://en.wikipedia.org/wiki/Synergetics_%28Fuller%29

[4] http://www.rwgrayprojects.com/synergetics/s09/figs/f86548.html



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