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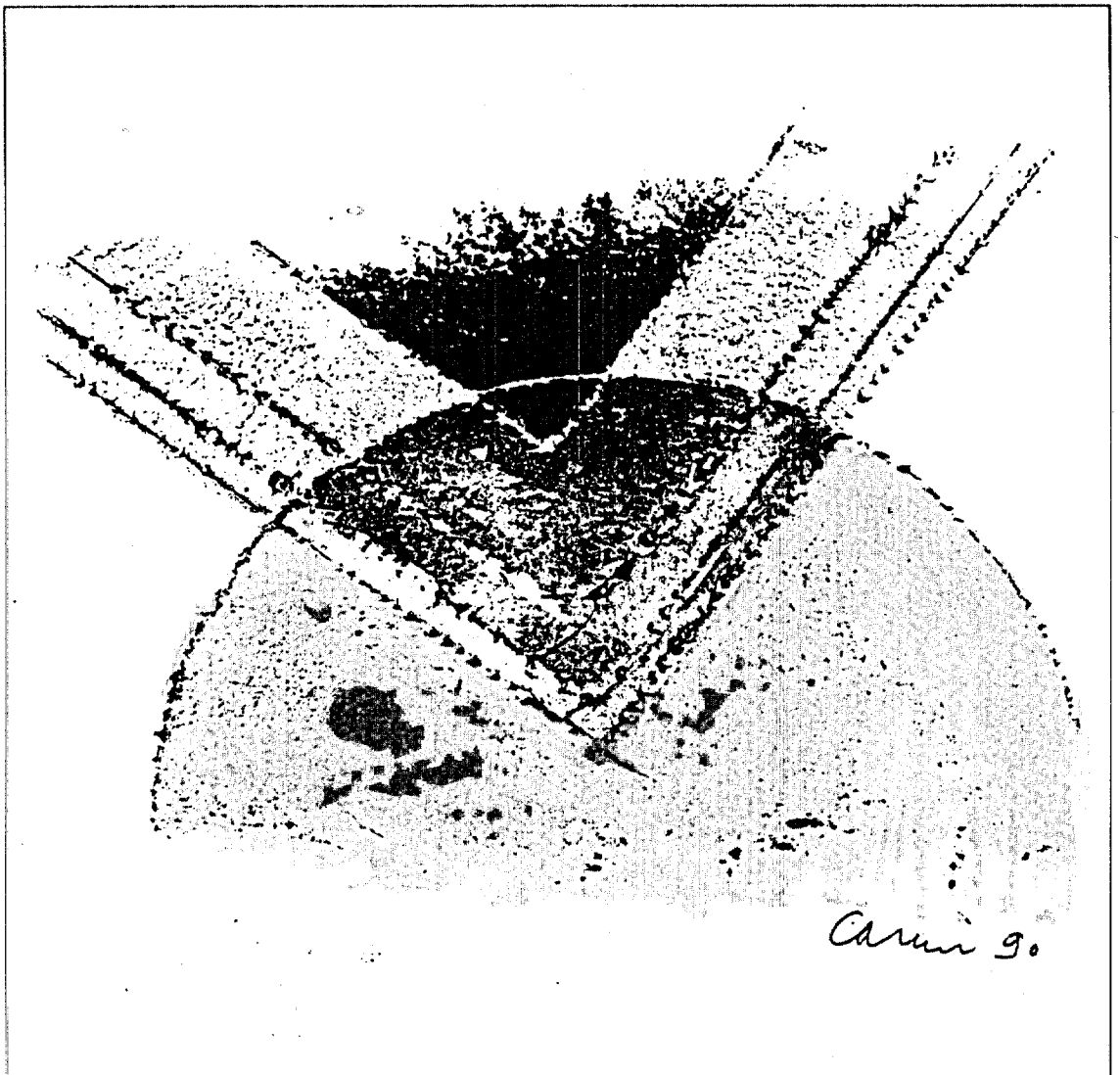

Symmetry: Culture and Science
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OBITUARY

CYRIL STANLEY SMITH
honorary member of ISIS-Symmetry
1903 - 1992

Interactions between the arts and the sciences

Dr. Cyril Stanley Smith was my friend and mentor. We met face-to-face when he first invited me to his summer home near Concord, New Hampshire. It was the perfect spot for a long discussion between this fine arts professor and this brilliant metallurgist, structuralist and so much more.

Dr. Smith's academic career had earned him the title of Institute Professor at the Massachusetts Institute of Technology which distinguished him as a faculty member whose work transcended individual departments and disciplines. His analysis of the boundary patterns between metal grains had inspired his general theory of structure which led him to found the Philomorph Society, a group of Harvard and MIT professors studying form and structure. He was the author of more than 200 articles and books. Among his awards was the Presidential Metal of Merit, presented with colleagues Enrico Fermi, Harold Urey, Samuel Allison and Robert Stone, for his work at Los Alamos, NM, directing preparation of the fissionable metal for the atomic bomb.

Dr. Smith and his wife, Alice, owned an early 19th century salt-box summer house at the end of a gravel road and with a view of the White Mountains. His study was a small, separate wooden building reached by walking a path bordered with juniper. This first meeting had followed earlier correspondence. We talked and drew diagrams for each other – always we drew for each other – for several hours and ended the day with cocktails on the lawn with our wives. He recognized immediately my new self all-space filling polyhedron and facilitated its publication in LEONARDO, Journal of the International Society for the Arts, Science and Technology.

The first meeting of ISIS-Symmetry in Budapest, Hungary, allowed me a whole week of the pleasure of his company. Dr. Smith's conversation was always stimulating and full of surprising insights. We even passed notes and drawings on the bus trip to Lake Balaton.

I last saw Dr. Smith in June before he died in August, 1992, at his home in Cambridge, Massachusetts. He was ill with cancer but his wife insisted that I visit and graciously said it would give him a boost. Again, we talked and drew for each

other and enjoyed lunch together with our wives and their daughter, Anne Denman.

I had the pleasure of visiting with his widow, son, daughter, son-in-law and his "computerized" grandson at that same New Hampshire house in June, 1994, following the ART/MATH conference at SUNY, Albany. Mrs. Smith, who always referred to Dr. Smith and I as "offbeat professionals", is now residing at a retirement home near her son, Stuart, in southern California.

Perhaps the best way to remember him is to quote from our correspondence that spanned years. His letters were full of wisdom and insight that should be shared. Most of his letters and even postcards included drawings. His letters meant everything to me and encouraged me to continue with my research.

Dr. Smith and Bob Wiggs in the office at his summer house in New Hampshire, 1985.

QUOTATIONS FROM DR. SMITH'S LETTERS

There are two ideas that reoccur persistently in his letters to me – lines and their junctions and things that don't fit.

1989: "I still can't decide whether the polygon, edge or the vertex is the most important, for all are essential. Mondays, Wednesdays and Saturdays, I believe in polygons, open spaces; Tuesdays, Thursdays and Fridays in vertices and lines; and on Sundays I worship the trinity. Vertex and polygon are the same except for scale and resolution in either space or time, and edge is simultaneously connection and separation."

1990: "Bob, I'm still obsessed with polyhedra and, ever since you discovered your octahedron with four triangles and four squares, I've been looking for other forms that are space fillers. Conclusion: space filling has nothing whatever to do with polygons or polyhedra but simply the lines and their junctions."

1990: "After years of insisting on the corpuscular approach as the most basic, in the last several months I have come to see that the only definite, countable things in natural and artificial structures are the LINES where corpuscular surfaces meet, and that all differences in what is usually called dimensionality disappear or rather merge into a substructure of connections and separations of lines."

1991: "I think we've got to abandon the idea of polyhedra entirely. For purposes of calculation, all structure seems to be reducible to lines – out-lines, in-lines and boundary-lines – and all history to kissing, missing and merging. No infinitesimal or differential, but simple arithmetical topology of separable lines and their junctions at unresolved vertices."

1985: "All problems of perception and understanding reduce to a scale of separation, junction and inclusion – and here's where our views join exactly – this can be demonstrated with lines and their junctions. Euclid prevented us from seeing that the trihedron with three diagonal faces is a regular polyhedron if one doesn't insist on the straight edges and plane faces required by geometric symmetry (ugh)."

1987: "The only things that 'count', i.e., that can be distinguished, are open spaces and the junctions of the lines separating them. This requires only the simplest Eulerian topology, not higher mathematics. No sines or cosines, no irrationals or transcendentals, no powers of square roots of minus one; in fact, no multiplication and division, only addition and separation are involved."

1988: "Straight lines are almost nonexistent in nature and they are utterly irrelevant to the topology of the junction. The only thing that matters is the hierarchy of the sharing of lines and vertices between polygons and polyhedra."

1988: "One makes precise logical mathematical statements whenever one draws lines and counts their terminations, intersections and joinings: and it doesn't matter in the slightess how many bends and wiggles there are between junctions."

1988: "The human eye looking at something enjoys only those things that don't fit. I, like you, have been fascinated by linear opposition and junction and think that most of our problems with understanding have come from an over emphasis on straight lines and space-filling polyhedra on one hand and Newtonian structure-free calculus on the other. The simple symmetries of crystallography hide the fact that the world is an aggregate of things that don't fit."

1991: "The solid state physicists recent discovery of the importance of lattice imperfection is far more important.

GOD said let things be ODD
EVE'N so said MAN"

1990: "I am currently obsessed with the turbulent forms in 3-D fluids which, at least macroscopically, are non-polyhedral without vertices: one has to ask where is the beef between your canine and bovine dentures? Every morning early I think of an approach that may be significant; by evening, I have convinced myself that it was nothing. But at least life stays interesting as the search for structure continues."

With very different educational and cultural backgrounds, Smith's in the sciences and mine in the arts, we both arrived at more or less the same conclusions about structure and demonstrated it to each other with very clear and simple drawings, models and diagrams. Our ability to communicate with each other, in spite of our differences, is a testimonial to the innate reciprocity between the arts and the sciences when its potential essence is fully developed.

Robert A. Wiggs
128 Hugh Wallis Rd.
Lafayette, Louisiana 70508
USA

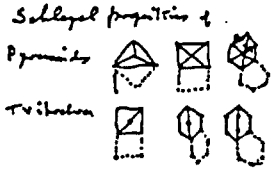
Drawings by Dr. Cyril Stanley Smith

We drew for each other and made models to illustrate the structures we were discussing on scraps of whatever material was available and profusely upon all postcards and letters. These are a few of Dr. Smith's sketches along with some of the accompanying text of the letter.

Conventional 3-D space filling is simply directional balance: Each line numerically marks a loss of freedom within the infinity of possibilities in universal unconstraint. Your sutures (which needn't be straight) say more than all the geometric cells of Euclidean polyhedra. Though it is useful to add divalent vertices which are both the beginning and the end of both things to connect and connections between things. My re-written form of Euler's law* says this, for the sum of [vertex valencies minus one] plus ONE is the sum of [polygons minus polyhedra] plus [lines], however distributed. The distinction between 2-D and 3-D space is a qualitative idea, applicable only to a local situation of countable (i.e. observable) beginnings and endings of those separations and connections, that are to be included or excluded within an arbitrary boundary.

The small Wigg's octahedron with concave lines that sits on our living-room table and has been commented on and enjoyed by our visitors more than any of the other "art" objects around.

Keep up the good work!



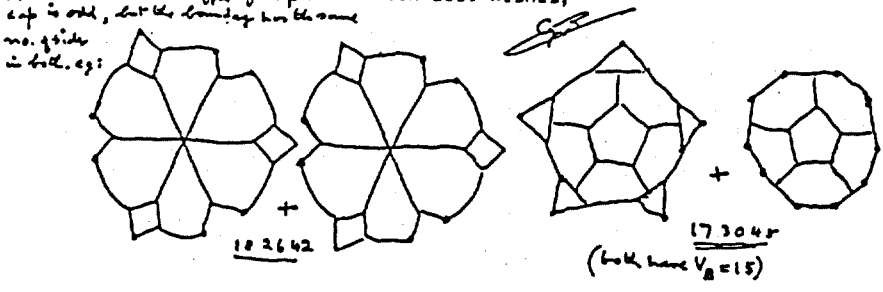
7 Sept 1990

$\Sigma(v-1)V_v + 1 = P - C + E$

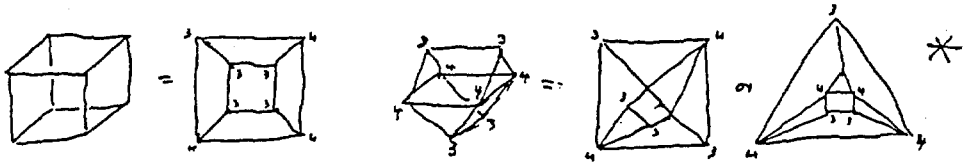
$\Sigma(v-2)V_v = 2(P-C)$

It was your octahedron that first made me realize the importance of prismatic space rather than polyhedra in crystal lattices. Thanks!

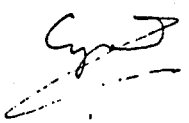
With best wishes,

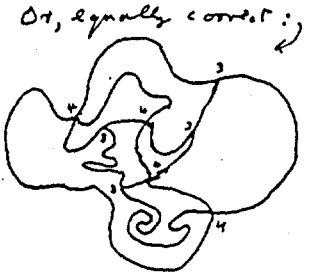


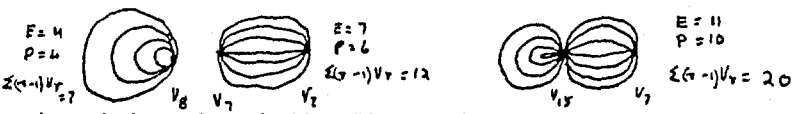
You would, I think find it very instructive to play with Schlegel projections of polyhedra. In these 2-D diagrams all the vertex valencies remain unchanged and the "missing" polygonal face has simply become the space outside the boundary, which, of course isn't a boundary when on the surface of a 'hedron. Thus, the cube and Wiggs8dron are depicted like this:



Warmest regards from Al and to Betty.

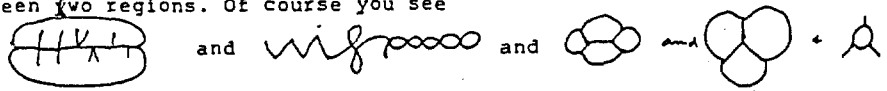




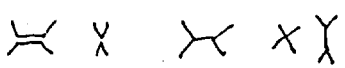


I'm using chains of such (P + E) groupings to prove some interesting things in number theory though I don't expect mathematicians to do anything but laugh at the attempts of a metallurgist to penetrate their logical fences.

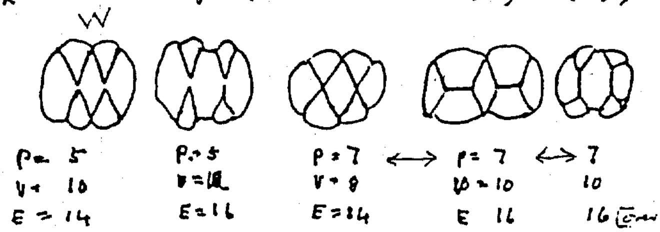
When does a bend become an abrupt change of direction? How finely sharpened is your pencil and how sharp your eyesight? A circle is a chain of particles related to each other and any junction is a change in direction of two surfaces. A line in a 3-D structure can become either a kink or contour in a 2-D surface, or it can be a "real" junction between two or more surface films. In either 2- or 3-D, a vertex is the junction of lines and there can be any number of lines joining -- the valence of the vertex being the number of detectably different separations of direction. Your sutures are simply two different basic forms of junction, two different associations of vertices on the (cellular) boundary between two regions. Of course you see

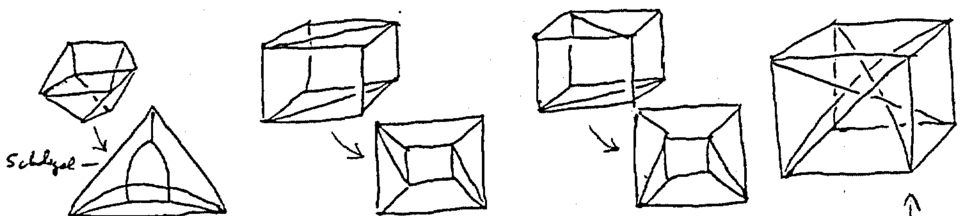


everywhere. The >-< is the Feynman diagram of the physicist.



I should have mentioned in my letter yesterday that your canonic + basic questions X &)–(do not change in any way the number of polygons or 'hedra or regions that are meeting, ($\Sigma(v-2)V_v$ is unchanged) – CSS





Two other octahedra, closely related to yours, each have four P-4, four P-3, four V-3 and four V-4 -- they are cubes with two opposite faces divided into two trigons, in directions parallel or normal (twisted) in relation to each other. On stacking, these generate an assortment of vertices of valence between 6 and 12 and may or may not add V-4s in the middle of faces depending on choice of orientation and whether the lines can be bent to bypass each other. The merest convention prevents one from regarding as a space-filling unit the net of 8 quadrivalent vertices (2E = 32) internally joined by bent diagonal lines that don't intersect, but it is a fine dense filler of space, made even more dense by internal junctions, the straightest being at a single vertex of valence 8 as in a body-centered cubic lattice.

All good wishes,

Dr. Smith and Bob Wiggs at ISIS-Symmetry, Budapest, 1989.

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A TRIBUTE TO CYRIL STANLEY SMITH

Born 1903, died 1992.

Metallurgist, historian of science and technology in relation to each other, and to art and artifacts.

I never met Cyril Stanley Smith. We were generations apart in age if not in attitudes. He was already in retirement when I sought his advice. I am not a systematic filer of such correspondence, but I kept his letters with me as the years passed. I knew that they could not be absorbed at first glance, and was grateful for their generosity of spirit. When he died I had the same sense that one might have a distant benevolent uncle is lost. If only I had asked him more questions...

Those who do not know the scope and power of his insights should sample them at first hand. His selected essays were published in 1981 under the title *A Search for Structure*, with some biographical notes. It is a pity that he did not produce a more integrated and comprehensive expression of his findings. The essays are packed with tantalising themes and tentative ideas which would have richly deserved such a treatment. He could well have written a worthy century-end sequel to D'Arcy Wentworth Thompson. What a pleasing symmetry there would have been in their two triple names!

He also wrote *A History of Metallography* and *From Art to Science*. They represent two stages in his evolution. Beginning as a metallurgist, he became increasingly fascinated by the history of his subject. He explored the complex interplay of science and technology through the ages, and then discerned a further deep connection, between the essential structures which underlay science and art. In the same period literary scholars have tended to the same view from the other side. Few of them can write like Smith!

He called himself a *philomorph*, a word which we might do well to adopt to encapsulate his characteristic approach. It was intuitive and pictorial, a deliberate reaction against the narrow methodology of quantitative science. He saw in materials a richness of forms, as the expression of forces, which had largely escaped his generation of physical scientists, except as failures to achieve some ideal, single phase in perfect equilibrium. He rejoiced, as did the poet Hopkins, in "dappled things" that had texture, beauty, life. He realised that the many complex systems which produced such effects had essential principles in common and fell into broad classes such as dendritic and cellular structures. In each case topology and geometry placed strong constraints on the possible, forcing the similarity of beer froth and grains of brass, imposing order within disorder.

Today we hold such subjects as chaos, fractal theory and pattern generation in high esteem, and must remind ourselves that they are of recent popularity, however ancient their antecedents. Smith was far ahead of his time. He stood alone and original, at least in his early days. For example, his references to the similarity of the complex structures of nature on all scales must have seemed fanciful. Yet today we recognise that the large-scale structure of matter in the universe resembles that of soap froth and those grains of brass which were his earliest concern.

Although he is remembered as a theorist he believed in the importance of direct experience as a stimulus to thought. He spoke of adventures with a Meccano set as a key ingredient of his early training. Scientists, he said, should be allowed to *play*. His advice to me in 1985 was: *I am delighted to hear that you are returning to experimental work with bubbles. Computers are superb for doing what one tells them to do, but one doesn't understand anything unless one has felt it with ones own muscles and produced an effect rather than just seen it develop. Computation is merely the last useful stage of a scientist's activity.* I went straight out and bought a kitchen blender, as specified.

I believe that his writings on the prehistory of solid state physics will never be equalled. That someone else will come along with the same combination of relevant experience, wisdom and interest seems improbable. He declared the history of that subject to be everything that was neglected by previous, conventional accounts of the development of modern science. He filled that void.

For all his protestations of amateur status as a scholar, he must have expended enormous time on the exploration of original sources, and new challenges to conventional wisdom.

Aphorisms abound in his writing. When A. L. Mackay was putting together his charming collection of scientific *bons mots* entitled *Harvest of a Quiet Mind*, he included one from on of Smith's letters. *Matter is a hologram of itself in the field of its own internal radiation.* Please, don't ask me what that means, but doesn't it make you sit up and think?

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