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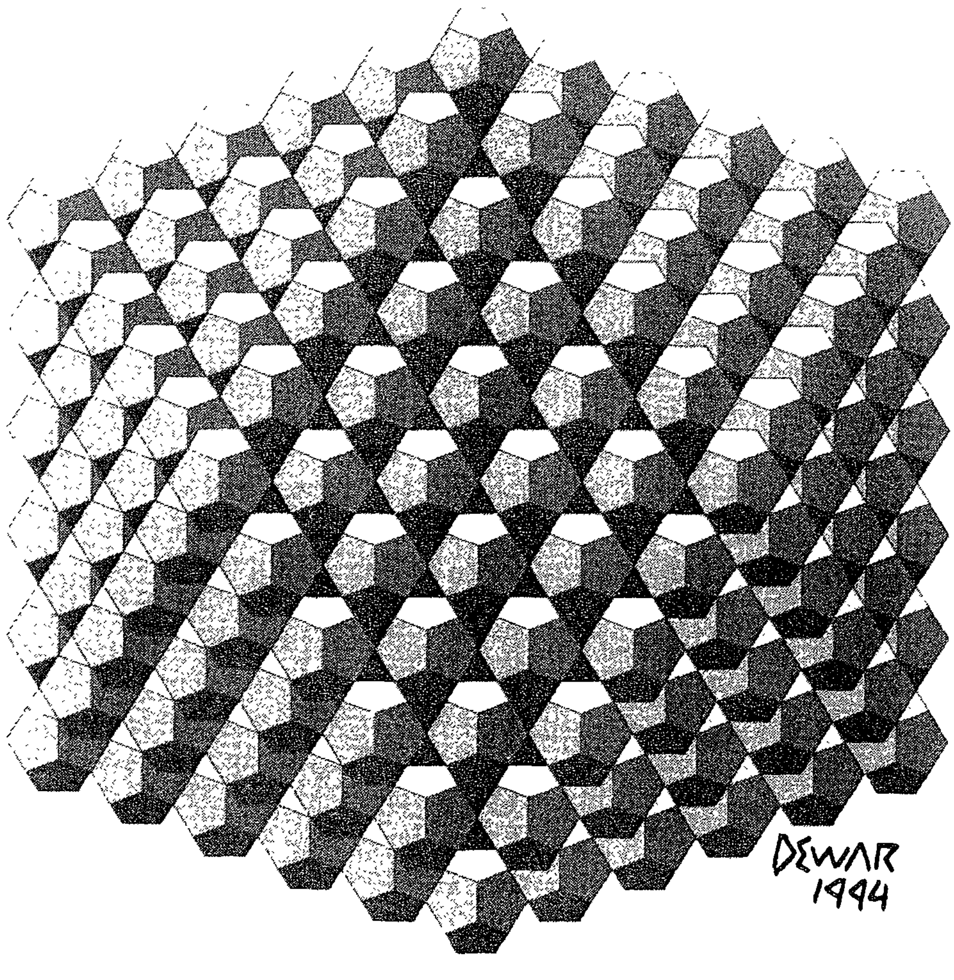

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VISUAL MATHEMATICS AS AN EXPERIMENTAL SCIENCE

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Buckminster Fuller looked upon mathematics as an experimental science like physics and chemistry, not a deductive system. He refused to accept postulates which could not be verified experimentally. We shall consider in particular three aspects of Fuller's Design Science philosophy. Fuller predicted that education would soon be the major industry in this country. Fuller took a discrete rather than a continuous view of matter, and he strongly believed in rational numbers, distrusting irrational ones to such an extent that he frequently believed that a rational approximation to a irrational number held a more fundamental truth than the irrational number itself.

We live in a three-dimensional world: all our material things are three-dimensional. Areas can be "measured" as long as thin homogeneous sheets of matter can be created from which forms may be cut: different forms may be cut out of these sheets, and their weights *compared.* In other words, we make an assumption that areas of forms are proportional to their weights, that is that weight is a manifestation in our three-dimensional world of two-dimensional areas. Of course, the *density* of the material from which the form is cut also determines its weight; this is exactly why we can only *compare* areas, assuming that they have been cut out of the same material having uniform thickness. There is therefore no way in which the absolute area of a square, triangle or any other form can be determined: areas and volumes can only be *compared.* If anyone arbitrarily wishes to use a square having an edgelength of one centimeter as a standard, that is her or his good right, and if Buckminster Fuller wishes to use an equilateral triangle as a standard, that is *his* good right. We note that Fuller's standard is in many circumstances the more practical one.[1]

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[1]Arthur L. Loeb: "Buckminster Fuller versus the Irrational, a double entendre" to be published.

By cutting and rearranging a number of basic theorems can be proven experimentally to build a fundament for a mathematics curriculum which does not make the unprovable assumptions so deplored by Fuller. From these theorems Pythagoras's theorem can be derived without the conceptual difficulties usually encountered in its proof, and a rational nesting of regular and semi-regular solids produces simple volume ratios for these polehedra.

Buckminster Fuller was more of the nineteenth and twentyfirst centuries than of the twentieth. His roots are with the New England transcendentalists, and his genius in discerning the significant pattern and discarding the insignificant one surely derives from these roots. His belief in rational numbers and discrete structures is reminiscent of the law of definite proportions and of Haüy's theory of crystal structure[2] eighteenth century. The dangers with such theories are unwarranted approximations to make the expressions elegant and simple, but incorrect. We shall see that Fuller, too, made some unwarranted approximations for his angles, but also that these approximations are unnecessary because most of these angles have in point of fact simple rational trigonometric functions.

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[2]R. Hooykaas: "The Historical and Philosophical Background of Haüy's Theory of crystal structure" Acadeniae Analecta, Brussels, Klasse der Wetenschappen, 56, 2 (1994)

In the Design Science/Visual Mathematics Studio at Harvard I have developed a curriculum in which Fuller's structures fit naturally and simply, using very little trigonometry, and assigning the numbers 1, 2, 3, 4, 5, 6, 8, 12, 20, 30, 48, 60, 120, special spatial significance.