From flatness to centeredness: defining empathy in design and why nature is the best designer

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In this article I will be elaborating a position first articulated by R. Buckminster Fuller. This position is that the geometry we rely on to inform and motivate our acts is central to our being in the world, and hence our ability to act with empathy. Buckminster Fuller uncovers how Euclidian geometry (flat earth thinking) can be contrasted with spherical geometry and what kind of impacts these two types of thinking have had, and are currently still having, on our ability to show empathy. Of fundamental importance to me in this article is to be able to convey the essential unity of all existence and that empathy cannot be expressed without a realisation of this. At the same time the critical method used in demonstrating this unity uncovers how nature is the best designer, and what the 'Project of Architecture' is in this context.
Key words: Euclidian, spherical, position, geometry, empathy, how nature builds, the 'Project of Architecture'

Van flathead tot gesentreerdheid: 'n omskrywing van empathy in antwerp en waarom die natuur die baste ontwerper is
In hierdie artikel brei ek uit op 'n situasie wat vir die eerste keer deur R. Buckminster Fuller geartikuleer is. Dit is dat die geometric waarop ons staat mask om ons dade te vorm en te motiveer, sentraal is ten opsigte van ons in-die-wêreld wees, en gevolglik ook ons vermoë om empaties te handel. Buckminster Fuller toon aan hoe Euklidiese geometric (plat aarde denke) gekonstrateer kan word met sferiese geometrie en watter soort impak hierdie twee soorte dense gehad en steeds het op ons vermoë om empaties te wees. In hierdie artikel is dit vir my van fundamentele belang om die essensiële eenheid van alle bestaan te verduidelik, asook dat empatie nie uitgedruk kan word sonder hierdie besef nie. Terselfdertyd demonstreer die kritiese metode wat toegepas word hoe die natuur die beste ontwerper is, asook wat die 'Projek van argitektuur' in hierdie konteks is.
Sleutelwoorde: Euklidies, sferies geometrie, hoe die natuur bou, die 'Projek van argitektuur'

The geometry that is taught at schools almost all over the world is Euclidian geometry. This same geometry is built into the software that is used by designers, architects and engineers to prepare documentation for the construction industry to execute building projects. Euclid (300BCE) made the assumption that there are straight lines and that these straight lines might be parallel to each other. We now know with absolute certainty that this is not correct and that there is not a single straight line to be found in physical manifestation, or any manifestation for that matter, other than the theoretical space of the draughting software mentioned above. This knowledge, it is evident, has not been acted on. To the contrary, we act in everyday life as though we inhabit a flat surface and not a sphere. Many people know the name Einstein and the famous E=mc² formula, but do not realise that the basis of this formula and Einstein's work is spherical geometry. Hence the singularity known as the 'Big Bang' is incomprehensible to many a layman and scholar alike and the wonderful knowledge of our essential unity demonstrated by this event goes by unnoticed. Fuller uncovered this behaviour, as well as its roots, in the Euclidean spatial conception employed by most of us in our everyday life. Evidence of this is seen everyday all over the world. People's acts are commonly motivated by separation based on the assumption that we compete for limited resources. In our own region an obsession with security is driven by a sense of otherness towards our neighbours, resulting in more and more separation and barriers and, essentially, a lack of empathy.

Now I think that you will agree with me with regard to the experience of separation evident in global affairs, but it may come as some surprise that this separation is to a large extent the result of our early education in geometry. I will admit that it is not quite so simple, but that for the purpose of this article it will be sufficient to convey the idea that separation in its negative forms, such as hierarchy, lack and competition are reinforced by the Euclidian spatial geometry.

This geometry finds expression in the architecture of our cities and homes. The square rooms we inhabit remind us only of a grid that extends out infinitely along the x, y and z axes.

I would like to briefly compare this grid made up of evenly divided blocks with parallel lines to a spherical space such as we actually inhabit, which is defined by a common origin, the 'Big Bang'. In the former spatial model or geometry any 2 positions have a connection only through coordinates distant from each other on the grid. There is no connection other than the distance that separates us. This arbitrary separation results in a moral relativism, and hence lack of empathy with regard to each other. In the latter model all positions have a common origin, which is the 'Big Bang'. The 'Big Bang' essentially points to a non-dualism fundamental in my articulation of design as empathy. To focus one's attention on a single point with the knowledge that all lines are curves engenders a feeling of connectedness not possible in an orthogonal grid. In other words, curvature is essential to empathy.

Consequently, if we can accept that we inhabit a sphere and not a flat plane, and that the floors we walk on are perpendicular to the centre of the earth, and that the short distance between two building floors already compensates for the curvature of the surface of the earth, we gain awareness, though seemingly innocent, that is transformational. Empathy in design must manifest as democracy or comprehensive inclusion. What would democratic architecture look like? And would this architecture be consistent with the 'Project of Architecture'? In the following section on practice-led research I will answer these questions.

Practice-led research

Practice-led research is defined as *the practice, process or method that generates results without the baggage of preconception or objects*. Consistency of results with respect to widening or opening up is crucial for a positive assessment of the research. In my particular case my method is to uncover any spherical geometry in manifestation, and to use this in a form of bio-mimicry to design with empathy. I will also introduce important buildings or architecture where the design expresses empathy. This is the case with many religious buildings. This fact will demonstrate a relationship between empathy and geometry.

Before I continue with my own research I would like to elaborate Buckminster Fuller's position as I am essentially continuing where he left off. In studying the closest packing of spheres, Fuller was able to uncover the geometry of the periodic table. He referred to this as 'Synergetic Geometry'. In a nutshell, he established the relationship between the platonic solids starting with the tetrahedron and ending with the icosahedron. These shapes form the fundamental patterns of all manifestation and are all spherical geometry. His vision was to integrate spherical geometry into everyday experience. The geodesic dome at the Montreal Expo of 1967 was his first major step in achieving this vision. The underlying geometry of this massive structure is the icosahedron. At every point of the icosahedron is to be found a pentagon with hexagons in between. The Nobel Prize (1998) for the discovery of the carbon 60 molecule was awarded to Kroto, Smalley and Curl. They named it the *Buckminsterfullerene* having been inspired by Fuller's dome at the '67 Expo. Kaspar and Klug were awarded the Nobel Prize (1982) for their discovery of the protein shells of viruses. They too were inspired by the Expo dome. This is evidence of Fuller's conviction that the dome is not only utilitarian or functional but that it is also instructive by pointing out the spherical nature of all manifestation. There are many other recent advances in science and technology that are based on Fuller's research and thinking. The efficiency and ease of geodesic dome construction has radically improved since Fuller died in 1983, which gives new currency to his vision and research. I will be expanding this point towards the end of this article under the 'idea of the house'.

Fuller believed that we learn by doing (after Dewey). By building and exploring spherical structures we get to know them and are exposed to and become absorbed by what he referred to as the 'art of design science'. I have based my research on the same premise. The practice of building spherical structures leads to the uncovering of the unity of all existence through the authentic exploration of all phenomena and the creation of relationships between phenomena through this process. In fact, the relationships established by the research constitute new phenomena in the history of architecture. I am confident that the research will speak for itself.

**A re-consideration of some important architectural monuments**

The first architectural monument is the pyramid complex at Cheops outside Cairo, Egypt. The shape of these pyramids is exactly that of an octahedron cut off at its base. The octahedron is a spherical geometry in that its six points all touch the circumference of the same sphere. The 8 sides are each an equilateral triangle. This shape is identical to the shape in which gem quality diamonds often occur. Is it possible to suppose that the Pyramids at Cheops are the first examples of bio-mimicry in architecture?
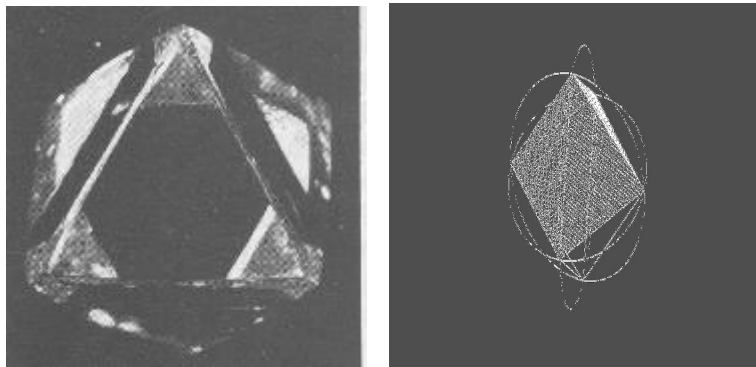
Diagram on the left: Pyramid at Cheops
Image to the right: An uncut diamond from Sierra Leone (Image from Webster, R. & Anderson, B. W. 1982. *Gems, their sources description and identification 4th edition*, Butterworths.)

The Taj Mahal is my second example. On the photo of the building I have super imposed the geometry. It is clearly evident that the design of the Taj Mahal incorporates the same octahedron in its geometry. I postulate that the beauty of this building is established by its consistency with spherical geometry.
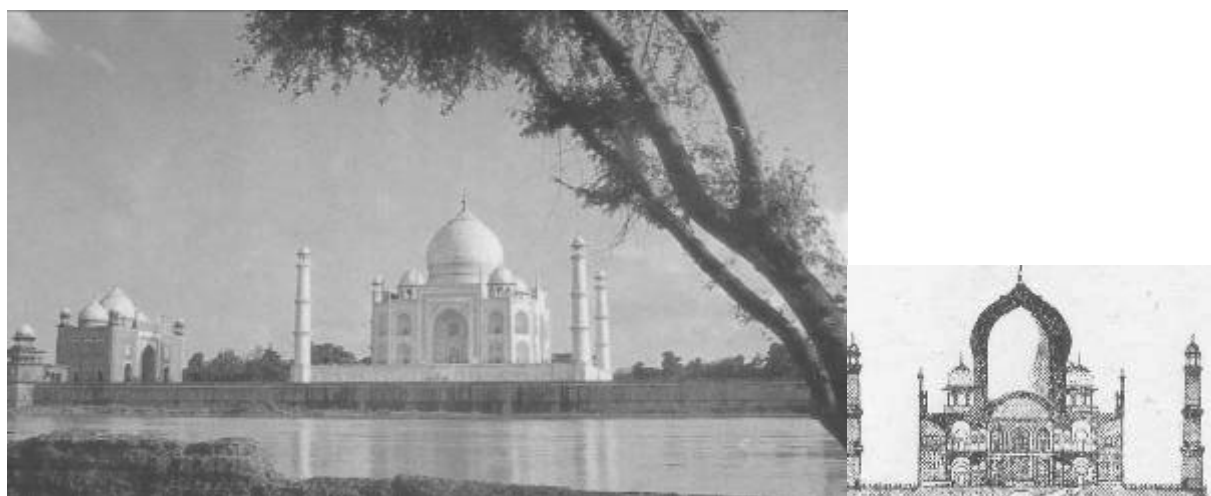
(Photo & section: courtesy India Cards, New Delhi)

My next building is more recent than the Pyramids but older than the Taj Mahal. This is the temple at Jagat near Udaipur in Rajastan, built approximately 1000 years ago (figure 1)[1]. Take note of *e* and *f* that are both illustrations of the profile of the interior of the temple. To clarify the significance we need to go to an illustration of a D'arcy Thompson[2] photo by Fuller in his *Project Noah's Ark # 2* (figure 2)[3]. Notice the geometry of the milk drop. Is this conclusive evidence that the temple at Jagat is an example of another architectural instance of bio-mimicry? It is perhaps also not coincidental that many deities housed in Hindu temples are adorned with diamonds?
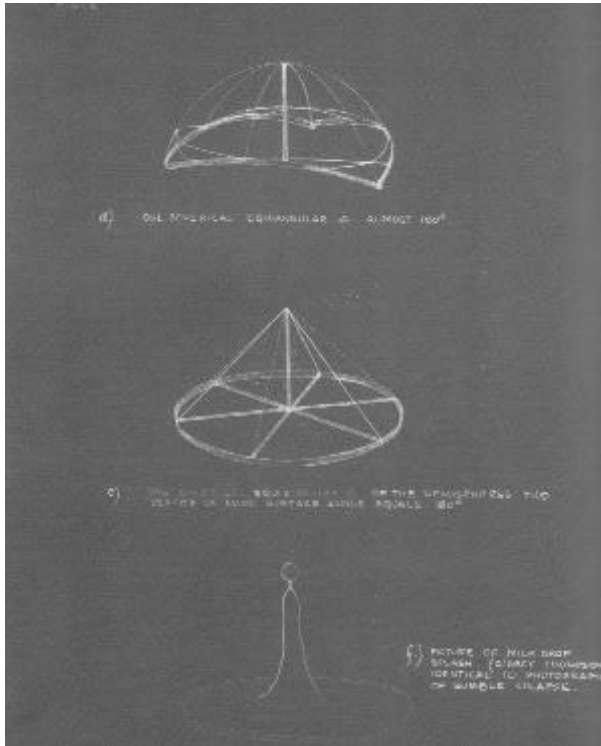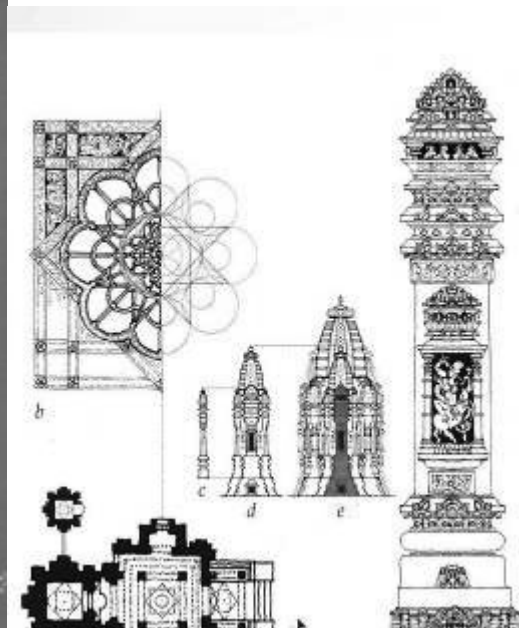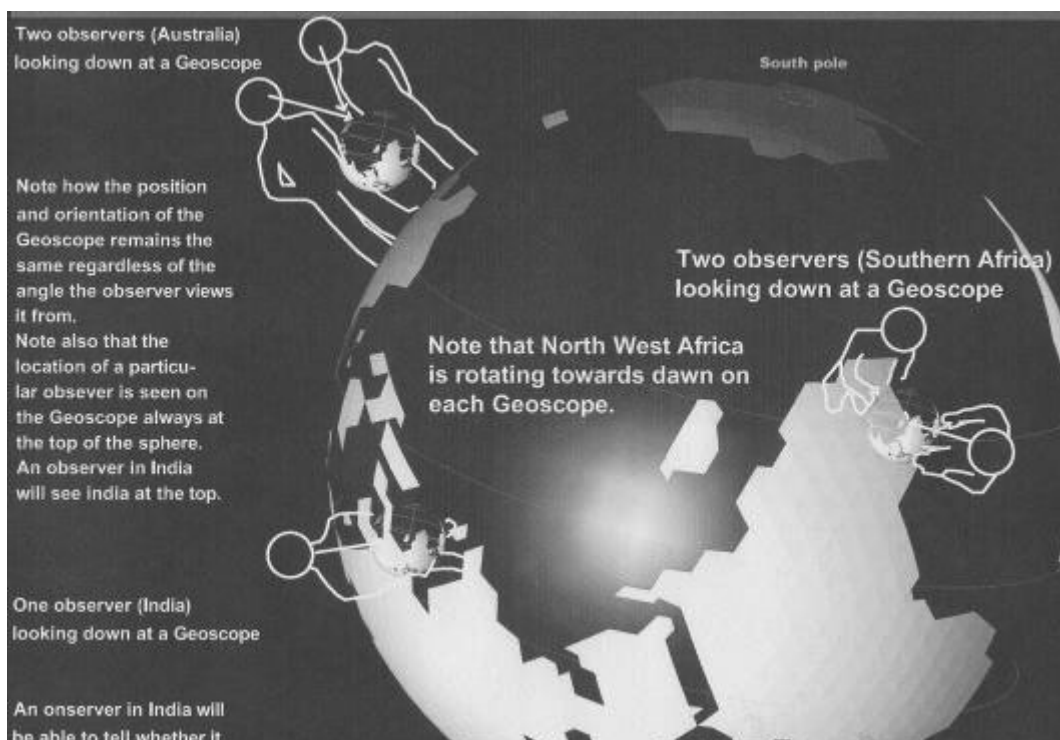

Figure 1

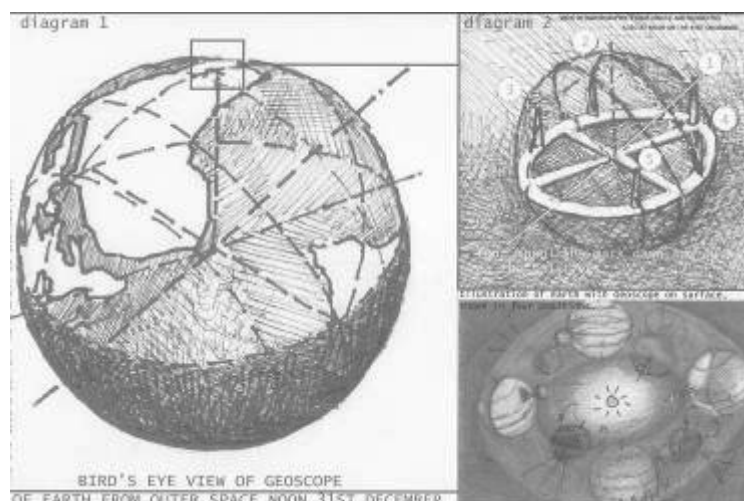**Figure 2**

A geoscope at Mapungupwe

In my next example I will propose an architectural reconstruction at Mapungupwe, an important historic settlement along the Limpopo River in South Africa. Mapungupwe flourished in the 13th century and at its peak might have had at least 5 000 inhabitants. Important archaeological finds, including some gold artefacts and Chinese ceramic beads, were found here. My reconstruction is based on Fuller's 'Geoscope' project. The Geoscope is a real time model of what the earth looks like from outer space. Any person looking at the Geoscope will become aware of the light conditions anywhere on the globe. In the illustration below we can see that observers in South Africa will be aware that it is midday in Madagascar and dusk in Australia. This is significant in that it enables me to have empathy with other humans as I know what time of day they are experiencing. More important in establishing empathy, is that I become aware that we are all equidistant from and perpendicular to the sphere's centre. The Geoscope dispenses with a notion of hierarchy because of this. The illustration below also clearly emphasises that regardless of where you are on the globe, your position will always be on top establishing a political correctness that avoids the North / South hierarchy reinforced by the media in representations of the globe. As Fuller has pointed out, the representations of the globe are almost always ideological and to assume that putting the North Pole at the top is innocent is a serious mistake. The representations of the globe on the main news channels contribute greatly to reinforcing the dominance of North over South.

The Geoscope is a tool that reminds us of our connectedness through a common centre and our equidistance from this centre. This essentially establishes the political equality of all humans, or democracy. Any spherical structure references this fact.

Returning to Mapungupwe, I would like to propose a re-construction of a stone circle found on top of the hill where the important golden artefacts were found. In an affidavit signed by a prospector by the name of Rouke in 1930, it is stated that he found a stone circle with five monoliths on top of the hill at Mapungupwe[4]. The monoliths - which were highly polished - had already been toppled but he gives their length. This enables us to determine that a line drawn from the top of a monolith through the centre of the circle would approximate the declination at Mapungupwe. We can infer that the other stones would then have marked the solstices. The uncovering of this possible geometry in my reconstruction brings to light the fact that this structure was a Geoscope. For us here in South Africa this is very significant as it reveals that the inhabitants of Mapungupwe knew that the earth was a sphere. It is further revealing of the ideological flatness of colonialism and post-colonial research to this day.


Illustration of a Geoscope at three different locations on the globe, namely South Africa, India & Australia.

Hemisphere as seen in the reflection of the calibrated divining bowl placed at the centre of stone circle.

With the aid of this reconstruction another enigma, namely the purpose of a number of wooden divining bowls from this region, is also solved. When filled with water these bowls could be placed in the centre of the stone circle and used as the eye piece and decoder for revealing the correct time to plant valuable sorghum and perform rites and rituals essential to social cohesion.[5] I will not explore this further in this article as I simply wish to illustrate the possible relationships that this method reveals.

I would now like to conclude my historical overview of important architectural monuments and their interpretation. All my examples reveal, each in its unique way, the meaning of design as empathy. The Taj Mahal was built as a demonstration of love. The temple at Jagat, now with its spherical geometry revealed, becomes the expression of non-dualism. At Mapungupwe the proposed reconstruction reveals a society possibly less feudal than previously assumed. And finally, the pyramids at Cheops are revealed as possibly the earliest examples of bio-mimicry, or *nature as the best designer*. The common view of huge slave armies having built these particular structures is more revealing with regard to the flatness of the ideologies of the societies that presented these histories in the first place, than with what actually happened. As yet it seems probable that they must have been built in another way yet to be discovered!

The 'Project of Architecture': democratic architecture

The illustration above shows a view of Tshwane from the famous Voortrekker monument. Included in the top view above the Freedom Park is a Geoscope, 100m in diameter. The orientation of the globe will be with its axis parallel to the earth's axis of rotation, and the position of Tshwane will be at the top. Any observer will notice this new orientation as different to that of the mainstream media. This will engender an awareness of equality, and hence democracy. The drawing on the bottom left is an elevational study for a memorial to Nelson

Mandela adjacent to the state theatre on what used to be Strijdom Square. Nelson Mandela is the central international human representative of democracy. Therefore it is apt that a memorial to him should be designed with empathy, and consequently be consistent with the spherical geometry I have outlined above. On the right an elevational study of the Hatfield Gautrain terminus is shown. These are all designs based on bio-mimicry or spherical geometry. These three new landmark structures will complete an assemblage of monuments around Pretoria or Tshwane that is instructive of democracy and the unity of all existence. This is then the 'Project of Architecture' or 'democratic architecture' or 'design as empathy'.
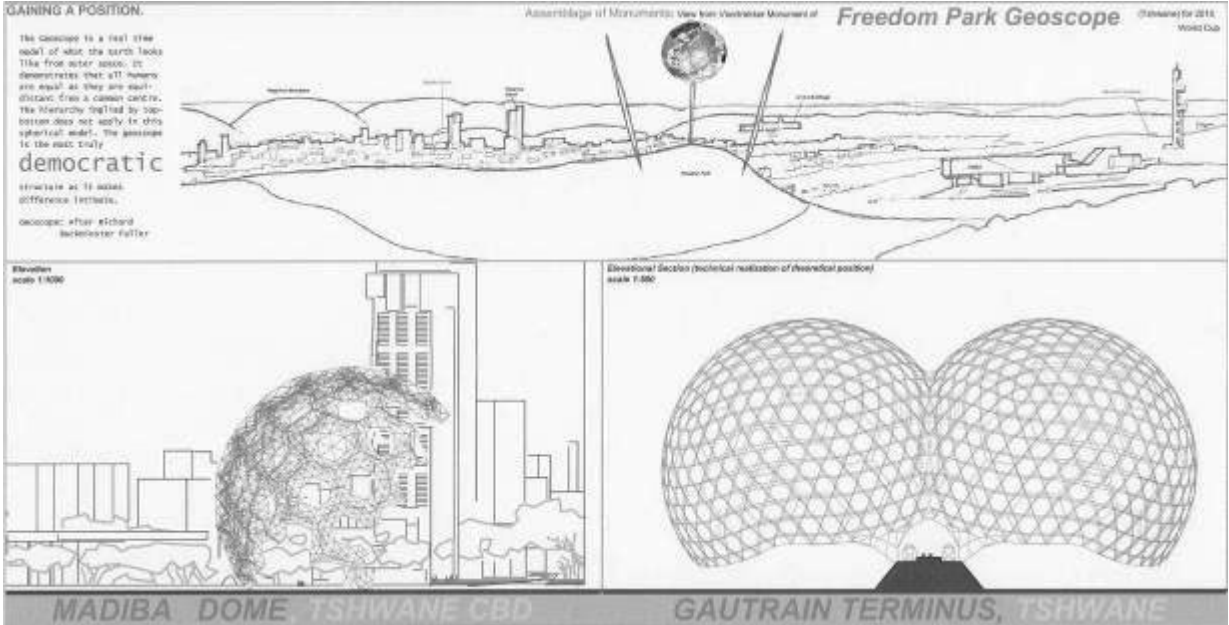
Some research that is revealing with regard to the consistency of this method

In the research example that follows I was interested in establishing the relationship between the geometry of the sphere and the torus or doughnut shape. I started with a single icosahedron and then determined how many I could add to complete a ring. The addition was done by joining together or sharing one equilateral triangle face. Initially I thought that I might need only six icosahedrons to complete the ring, but to my astonishment nine where needed to do this. Nine is a very special number. When you multiply nine by any whole number the following is revealed:

2 x 9 = 18	1 + 8 = 9	
9 x 9 = 81	8 + 1 = 9	
18 x 9 = 162	1 + 6 + 2 = 9	
857 x 9 = 7713	7 + 7 + 1 + 3 = 18	1 + 8 = 9
85967 x 9 = 773703	7 + 7 + 3 + 7 + 0 + 3 = 27	2 + 7 = 9

In another experiment I was surprised to see that when one takes an octahedron and adds another by making them share an equilateral triangle face, and then another, and so on, one arrives at five octahedrons forming the pentagonal top of an icosahedron. Continuing the same procedure, one arrives at a sphere consisting of 12 pentagonal faces and 20 equilateral triangular faces. The interior of this shape results in an icosahedron. The diagram and photo of the model shown on this page will help to explain this amazing consistency. I used this geometry to design a light that, shining in peoples' homes, also engenders a sense and experience of unity as well as empathy. Of particular importance with this research is that the relationship between the

octahedron and icosahedron is systematised and uncovered in a way not done by Fuller or anyone before him.
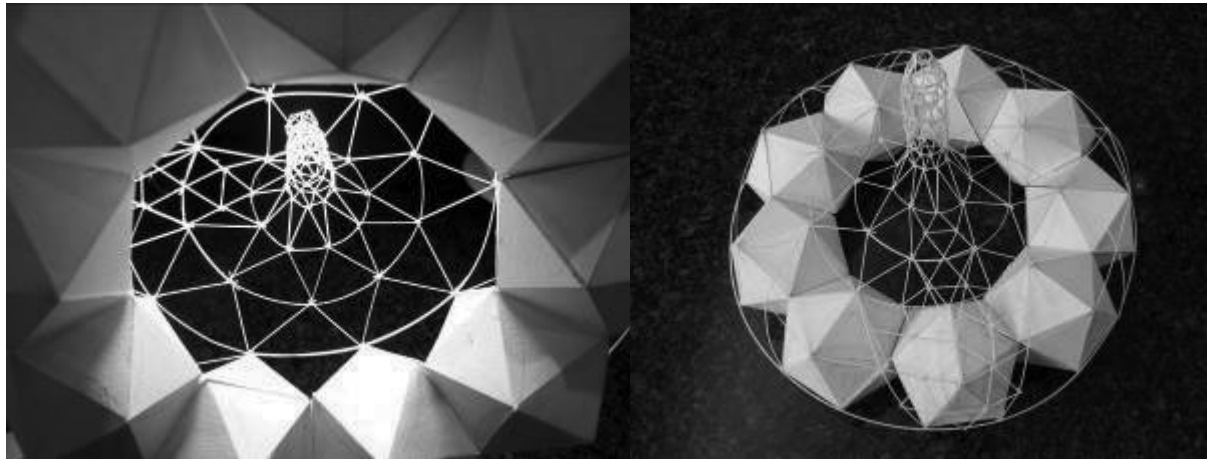
**And so on infinitely.**
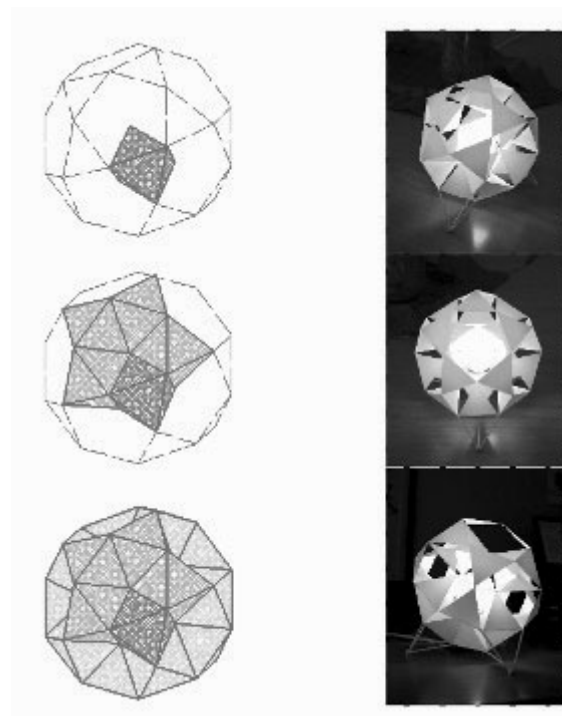
The 'idea of the house'

Fuller wrote that if we look at the world population distribution it is evident that humans must have evolved from the tropics of South East Asia across to the horn of Africa and then gradually moved up the great river valleys like the Indus, Yangtze and Ganges[6]. The tropics provide ideal living conditions, such as comfortable temperatures and abundant sources of food on land and in water. He writes that dolphins and humans have a common ancestor that might have lived 20 million years ago. At a certain point a split took place where the one branch developed further in an aquatic environment while the other branch developed or evolved further on dry land. This is contrary to the common view that we share a common ancestor with the apes. What Fuller was trying to point out is that the semi-aquatic environment of the tropics did not require us to inhabit caves or build structures to protect us from the elements. In fact, our inquisitive disposition would have us invent the boat to explore the oceans before we invented

the house. The 'idea of the house' actually comes from the boat. When reaching less hospitable environments further away from the tropics by boat the sailors would use the upturned boat as protection. We do actually find many roofs in various parts of the world that look like upturned boats. So this means that ideally we prefer to live in the open as we did in the comfortable environment of the island tropics. For the first time in history it is now possible to feasibly do this in less comfortable parts of the globe. The house as a skin that is adaptable to the various extreme conditions experienced throughout the year can now be built with the new technologies available on the market. Computerisation in manufacturing and sophisticated materials that are light and strong, with variable transparency, as well as being easy to manufacture, enable us to dispense with the heavy primitive labour intensive technologies we currently use to build comfortable habitation. More crucial to the gist of this article is that we have also been liberated from the orthogonal geometries normally associated

with the conservative construction industry. Ten years ago it was still very important to standardise and repeat elements to keep the cost of fabrication and construction down. This has now changed as computerised cutting arms work off building information models that obviate the need for repetition and standardisation. Building geodesic domes, such as the dome designed by Fuller for the Montreal Expo of '67, has become much easier. With sophisticated prefabrication of elements the problems of waterproofing the enclosure have been solved and the criticism that Fuller and dome builders had to endure is now irrelevant.

This brings me to my final example of design as empathy. The design illustrated below is of a proposed house on a sloping site at Hartbeespoort Dam near Pretoria, South Africa. The design simply consists of a geodesic dome made of prefabricated EFTE cushions. Ablutions and sleeping areas are still contained partially by orthogonal walls under the main living area, but the experience of the inhabitants will be that of living outside. The spherical geometry creates the most efficient structure, as well as facilitating circulation and convection, obviating the need for mechanical ventilation. In addition, the height of the structure allows large trees to be grown inside, giving the experience of 'Eden'. The 'Eden Project' in Cornwall, England, designed by Nicholas Grimshaw and completed in 2001, achieves the same on a much larger scale while also using EFTE cushions. His inspiration, need we guess, was none other than Buckminster Fuller.
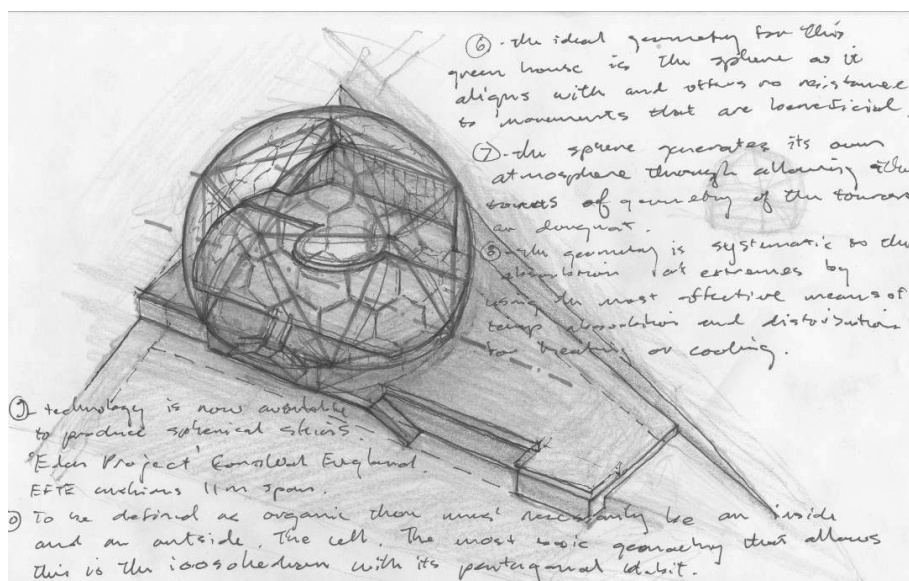

The drawing above is a design sketch for dome house.

From flatness to centeredness: concluding remarks

Our thoughts create our world. Hence the importance of ensuring that we think the thoughts that will create the world we desire. One way of ensuring this is by providing ourselves with reminders that direct our thoughts to empathy as opposed to separation. Our uniqueness is always given as we are constantly reminded of this by the bodies we inhabit. More important is to remind ourselves of our unity, common purpose and origin. This is what spherical geometry achieves, by reminding us of the non-dual or Divine. In truth, the pinnacle of human evolution, from the singularity of the 'Big Bang' fifteen thousand years ago, is to realise this.

My final illustration is a view from the inside out. That is a perspective view from the centre of the geodesic dome proposal, or for that matter, from the centre of the 'Big Bang'.
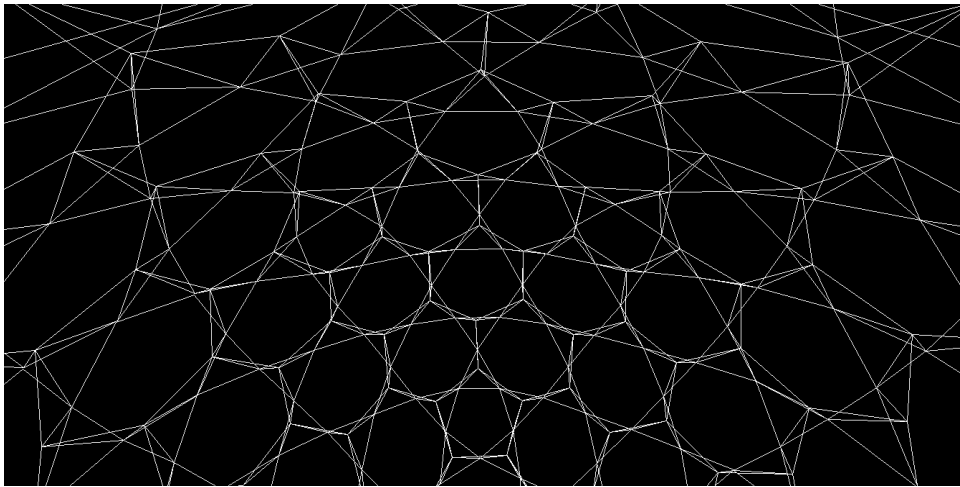
Notes

1. My illustration and knowledge of the building comes from Hardy, A. 2007. The Temple Architecture of India, John Wiley & Sons.

2. D'arcy Thompson, On growth & form, 1917.

3. Completed in 1950 and published in Krausse, J. & Lichtenstein, C. 2001. Your Private Sky: Discourse R Buckminster, Lars Muller.

4. This document is housed in the Mapungupwe Collection at the University of Pretoria.

5. See the small illustration in the top right corner of the position of the bowl and observer to see the reflection.

6. Buckminster Fuller, R. 1981. Critical Path, St Martins Press.

All drawings and illustrations by the author unless stated otherwise.

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