From the desk of Pierre Beaudry

FILIPPO BRUNELLESCHI'S MIND AND THE CATENARY PRINCIPLE

By Pierre Beaudry, January 6, 2012.

(For the 600th Anniversary of the birth of Jeanne d'Arc)

«Taking an egg, therefore, all those masters sought to make it stand upright, but not one could find the way. Whereupon Filippo, being told to make it stand, took it graciously, and, giving one end of it a blow on the flat piece of marble, made it stand upright. The craftsmen protested that they could have done the same; but Filippo answered, laughing, that they could also have raised the cupola, if they had seen the model or the design. And so it was resolved that he should be commissioned to carry out this work, and he was told that he must give fuller information about it to the Consuls and the Wardens of Works. »

Vasari

Figure 1. Filippo Brunelleschi (1377-1446).

When you study the cupola of the Cathedral of Florence, you are not studying an object; you are studying a state of mind of artistic composition. To be precise, you are studying the galactic creative state of mind of Filippo Brunelleschi and the factor of time of the 16 year period it took him to give birth to the Italian Renaissance. This time factor was not measured by clock-time but by the accomplishment of an axiomatic change that was measured by the curvature of the catenary principle. Brunelleschi projected the sky hook of his mind into the future and pulled himself up from there. We are in a similar situation today.

Brunelleschi needed to know, ahead of time, how the total weight of the cupola was going to be distributed before he even laid the first brick, just like we need to know, as Lyn said, how thermonuclear fusion will work before you start thinking of going to Mars, because the time has come when the curvature of the human mind needs to be changed in time. It is that change in the curvature of the human mind, represented by the catenary principle, or rather by the singularity of change from the geometry of the circle to the geometry of the torus, inside of your mind, which needs to be understood in order to solve the crisis of today; nothing else will work.

Brunelleschi solved this problem by making an axiomatic change in time to transform the way everybody else was thinking during the first half of the Quatrocento. He succeeded with the cupola, and with a lot of artists of that time, because the time had come for instituting this new state of mind, focused on the future, and from the top down. When he was asked by the Wardens of Works to give them a plan, instead of starting from the beginning like everybody else proposed, he said he would rather start from the end and work his way back from there.

The paradox was to organize the maximum stress with the minimum external support starting from the lantern. That is also how the fusion process works. Everybody said Brunelleschi was crazy and that his idea would never work. There are times, however, when only crazy ideas such as this one will work and nothing else will, and this is the idea that is necessary for today. This report includes the following polemical ideas:

This report can also be found on my web site: *amatterofmind.org*

INTRODUCTION: THE IMPOSSIBLE CHALLENGE OF LEARNED IGNORANCE.

> ***"Start from the end and I will tell you how you are going to end up."***
>
> Dehors Debonneheure

Begun in 1296 by Arnolfo di Cambio, the Florence Cathedral was completed 140 years later, in 1436, by Filippo Brunelleschi. The completion of the cupola in Florence marked the beginning of the Italian Renaissance The Cathedral became the seat of the 1439 Council of Florence presided by Pope Eugene IV and organized by Cardinal Nicholas of Cusa. Along with Cusa, Brunelleschi gave the Italian Renaissance its greatest impulse in creativity and it's most enduring scientific and cultural inspiration.

The problem that this Florence Cathedral posed, however, was that it was impossible to complete because nobody knew how to erect a cupola without external support. The challenge, therefore, was to discover a new universal physical principle of construction which would be, as Brunelleschi put it, "***sans armadura***;" that is to say, "without framework." The problem was not a matter of cost. The issue was a matter of mind. In other words, Brunelleschi had to discover a self-sustaining principle of construction by means of which he would erect the greatest dome in the world without a leg to stand on; that is, by gaining total control over gravity in time.

Figure 2. Santa Maria del Fiore, Florence.

The two greatest domes of former times, the Pantheon in Rome and Hagia Sophia in Istanbul, did not require the discovery of any new physical principle for their erection, because those two churches had brought to the limit of feasibility the erection of great spherical domes, by means of the method of construction from the bottom up; that is, with the use of central wooden platforms and multiple scaffoldings that took care of the two problems that every dome builder encounters, compression and tension, or more commonly known as push and pull, in order to prevent excessive outward horizontal thrust that architects call “hoop stress.” which causes domes to stretch at the circumference of their base. Note the (1) first stone chain at the base of the Brunelleschi cupola (**Figure 3.**)

Figure 3. Internal structure of dome: (1) first stone chain, (2) internal walkway within shells, (3) transition from stone to brick masonry, (4) timber ring, (5) second stone chain, (6) vertical rib, (7) horizontal arches, and (8) third stone chain.

Figure 3 “STRUCTURAL DESIGN AND CONSTRUCTION OF BRUNELLESCHI’S DUOMO DI SANTA MARIA DEL FIORE,” by T. Russell Gentry and Anatoliusz “Tolek” Lesniewski.

However, for Brunelleschi, what was essential was the discovery of a method of erecting the great cupola of Florence from the heavens; that is, from the top down. The task required a state of mind that was completely different from everyone else's. The task was fundamentally galactic in character. The question was: how do you replicate the principle underlying the dome of the heavens and apply it to the 140 year old octagonal drum of the church of Santa Maria del Fiore?

Part of the answer to this question is found in Cusa's ***isoperimetric principle of least action***. But, the principle of Cusa was not sufficient. Brunelleschi had to devise, first in his own mind, the completed form of a self-erecting cupola that would be completely self-sustaining in each of its parts as well as in its totality. His problem was to discover what sort of new universal physical principle could resonate in accordance with the isoperimetric principle of Cusa and be applied to a new form of paradoxical cupola that never existed before, that is, a Gothic Dome. The fundamental requirement was to establish a dynamic vault structure which would be self-reliant and would be erected without any external support. This intention required the discovery of a new physical principle of least action above and beyond what Cusa had already discovered, and above and beyond already existing architectonic principles. The problem required going beyond the limits of simple circular and spherical action, and Brunelleschi was standing alone in front of the future asking: "How do you go beyond the limits of an axiomatic change?"

Specifically, what Brunelleschi had to do was to discover how to go beyond the limits of positive curvature exemplified by Romanesque domes and arches of the past. He had to break completely with tradition and with every architectural idea that existed up to that time. He had to discover how the principle of positive curvature and the principle of negative curvature came together harmonically. That was the only way to solve the limitations posed by the Florentine cupola.

By investigating the new domain of negative curvature with Cusa, Brunelleschi was already preparing the terrain for Leonardo da Vinci, Leibniz, Gauss, and Riemann's transcendental functions of elliptic and hyperbolic constructive geometry, and he was expanding human knowledge in the direction of a new form of galactic thinking that required the investigation of singularities of magnetohydrodynamic nature, such as shock waves in the domain of universal cosmic radiation. It is by studying the limit conditions of such an axiomatic system like the system of positive and negative curvatures of a cupola, and by introducing new hypotheses for experimenting with the tensile capacity of change in curvature under great pressure that new discoveries of principle are made. Those are the non-linear conditions that Brunelleschi required to apply to his cupola that Cusa helped to bring about.

What Cusa introduced in his 1440 publication of ***Docta Ignorantia*** was the sort of meditation that Saint Augustine had already identified as the extra measure of help that God brings to man when he recognizes his weaknesses at the limits of his creative thinking process. As Augustine put it: "***Therefore, as I say, there is in us a certain learned ignorance, but learned from the Spirit of God, who helps us in our weakness.***" «***Est ergo in nobis quaedam, ut dicam, docta ignorantia, sed docta spiritu dei, qui adiuvat infirmitatem nostram*** » (Epist. ad Probam 130, c. 15, § 28) That is to say, at the limit, there is a knowledge of principles that is beyond sense-perception and beyond human understanding, but which is located in the axiomatic changes that Brunelleschi and Cusa identified as the boundary conditions between scientific knowledge, artistic composition, and the infinite. Cusa provided Brunelleschi with the knowledge that would lead him to discover the solution to the identification of opposites in his own domain of architecture, which made him solve the minimum-maximum paradox of the greatest artistic composition ever built. Brunelleschi's paradox consisted in discovering how to generate, inside of the cupola, a unity of effect that would bring together those two simultaneous and opposite forms of positive and negative curvature. The key to unlock that mystery was to mix together the principles of positive and of negative curvature proportionately and harmonically.

1. THE CUPOLA'S DOUBLE POSITIVE AND NEGATIVE CURVATURE.

> "Strain is never caused by stress. Strain is caused by a defective curvature in physical space-time."
>
> Dehors Debonneheure.

If you wish to understand how the mental process works together with the galactic process, you have to examine how Brunelleschi connected the catenary principle and the isoperimetric principle to generate the doubly-connected positive and negative curvature of the cupola of the Florence Cathedral. Curiously, the same two principles are necessary to understand the mental behavior of the galaxy as a physical space-time doubly-connected manifold. See my report on Fusion Power is not Democratic.

Let's summarize the process, again. First of all, Brunelleschi started to build his cupola from the top down. He connected the Cusa isoperimetric principle with the catenary principle in order to first solve the problem of the Lantern. Indeed, how could such a heavy lantern be erected onto the cupola without crushing everything under its weight? Then, he introduced the idea of four sets of stone and iron chains that encircled the eight ribs of the cupola, like major third divisions of a musical octave, with such intervals as C, E, Ad, C; two at the top and at the bottom, and two equally spaced in between, thus dividing a paradoxical gothic conical dome into three separate areas of stress in accordance with the conical spiral divisions held together by chains**.** These consonant chains act as shock absorbers at equal intervals of the cupola, like singularities through which the stresses of the cupola as a whole resonate by allowing for change in time, and also by absorbing the regular shocks of lightning strikes against the lantern. As a result, the cupola became capable of taking a maximum amount of stress with a minimum amount of external support. This is the central organizing principle of the cupola.

The four sets of chains encircling the circumference of the inner and outer domes also have the function of transferring the pressure of the cupola onto the eight ribs of the cage which carry the entire weight of the dome, including the lantern. This function is very similar to that of stays which carry the weight of a hanging roadway such as the Brooklyn Bridge (**Figure 6**), or which calls for flying buttresses to take the outward thrust from the main body of a gothic cathedral. The double curvature of the cupola concentrated the power within its closed configuration like the gestalt formation of a new principle containing all of its elements within itself. In this way, the curvature was capable of channeling the lateral thrusts of the cupola all the way to the ground without danger, as if by defying gravity.

The critical containment and the key resonating feature, however, was the negatively curved herringbone or ***spinapesce*** brick pattern of negative curvature. The sixteen great spiraling herringbone membranes of both shells acted as cohesive self-supporting arches between every two of the great ribs of the cupola to secure the bricks in place while the mortar was setting. The whole process had to be done in time, because the whole purpose of the herringbone design was to transfer the weight of 4 million bricks horizontally onto the eight vertical ribs before they slipped to the ground. This was a doubly-inverted function which generated negative curvature as a physical space-time function. In that sense, the cupola was the first scientific application of a self-sustaining zero-gravity system formed by a doubly-connected manifold of negative and positive curvature, that was generated by the contradictory functions of the isoperimetric principle and the catenary principle. The bricks were all arranged to reduce the effect of gravity by means of combining the power of those two principles. This is the inverse of what happens on a trip to Mars where gravity needs to be increased by acceleration or deceleration. Here, gravity must be decreased to zero. As a matter of fact, this is always how an axiomatic change works.

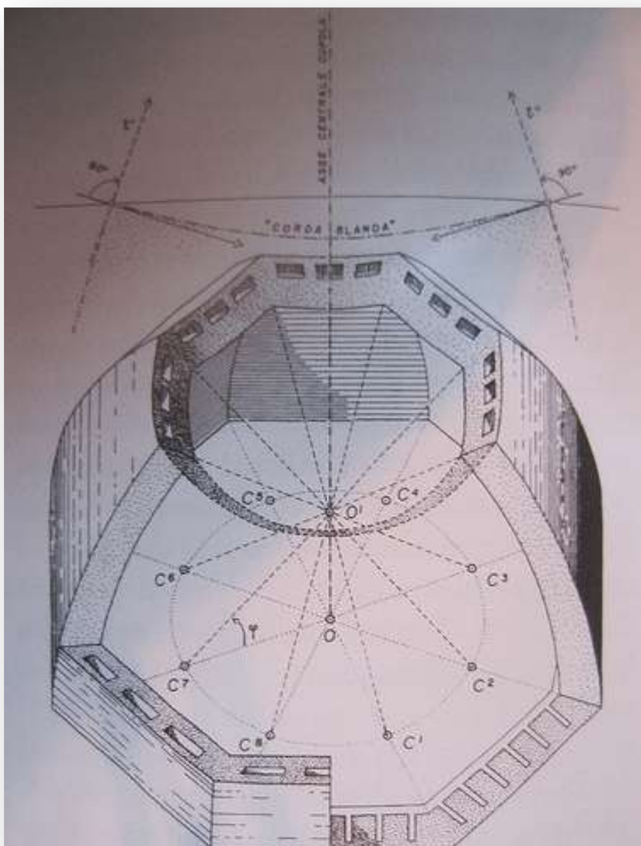

Figure 4. The combination of the catenary "***corda blanda***" (slack line) measure for the herringbone bricklaying with the radii of the isoperimetric pointed fifth and pointed fourth (C") integrate the positive and negative curvatures of the whole cupola. (Image by Ippolito and Peroni, ***La Cupola di Santa Maria del Fiore***, 1997)

A similar self-sustaining process of physical space-time curvature exists in which a galaxy or a nebula evolves through retarded or accelerated contraction of its plasma jets though the compression of both positive and negative curvatures of their magnetic fields. The chains of the Brunelleschi cupola act like compressed magnetic fields against the outward gravitational thrust of the cupola, while the vertical gravitational tendency of the 4 million bricks' motion, which is perpendicular to the constantly changing radii of curvature of the membranes, is pulled back horizontally toward the ribs by the inverse curvature function of the catenary. This is how force-free plasma vortex filaments of large numbers of electrons organize each other into definite patterns of self-sustaining curvature inside of the galactic magnetic field. Similar accelerated electromagnetic ram actions, as occurring in active galaxies, have also been observed in laboratories such as the Livermore National Laboratory. (See Winston Bostick, ***A way Out of the Quasar Redshift Shambles***, July-August 1989 issue of 21st Century)

This ultimately demonstrates that strain is not generated by stress, as modern theory on elasticity claims it to be. It is not by eliminating internal stress in a linear manner that the Brunelleschi cupola was able to resist the powerful compression of gravity, but, in fact, by increasing the internal energy flux-density of the cupola with an axiomatic change in curvature. As for the cracks in the cupola that have been observed in the 1980's, they are due mostly to seismic activity, and not to any faulty conception of curvature. "The increase in the width of the cracks took place in a period characterized by considerable seismic activity as well as by variations in climate and by a lowering of the water-bearing stratum." (Gianni Bartoli, Andrea Chiarugi, and Vittorio Gusella, ***Monitoring Systems on Historic Buildings: The Brunelleschi Dome***, Journal of Structural Engineering, June 1996, p. 672.)

Now, after consideration of these few elementary components, ask yourself: how can the catenary principle represent the interconnectedness between the universal galactic process and the mental process of the creative human mind? First and foremost, don't look for the presence of the catenary chain in the structure of the cupola, as such. The catenary principle is not a sense-perception thing. Examine, instead, the ways in which invasive singularities act on the human mind in a doubly-connected way, and look at how similar processes are reflected into the higher domain of galactic activity. In fact, similar processes operate from the same truthful and moral principle of bringing together a minimum of external support within a maximum of internal stress, as Cusa and Brunelleschi demonstrated in their respective thought processes. This is not just a structural principle; this is an architectonic principle of the creative mind with respect to final causality.

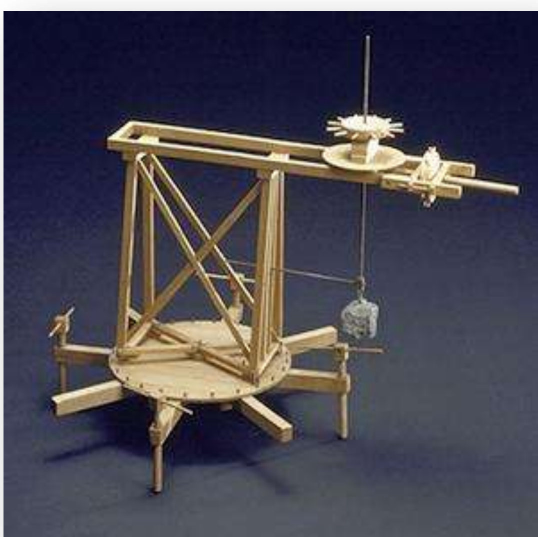

Figure 5. Working model of a revolving crane that was built on top of the cupola for the erection of the Lantern following a drawing by Leonardo da Vinci. (***Dipartimento di scienza delle costruzioni, Università di Firenze.)***

I might add that, like all new grand design projects, the Brunelleschi cupola required the invention of new technologies and machinery that had not existed before. Brunelleschi designed many such new machines that Leonardo da Vinci examined closely and drew in his own Notebooks, notably the doubly-connected revolving crane with a load-positioning device that Brunelleschi originally designed and which was later built for the construction of the lantern, after his death in 1446.

For the benefit of those of you who do not believe in sense-certainty, you should be happy to hear that, for the best part of the 16 years that it took to complete the cupola, not a single person standing outside or inside of the Florence Cathedral could see how the cupola was erected. It was Brunelleschi magic at its best. All they saw, from the inside, or from the outside, were the two shells growing up together and by themselves, thus, confirming for those who had any doubts, that the cupola was based on a self-generating principle. The reason for the magic, of course, was that all of the workers were located in the stairwell between the two shells, and therefore, they were all hidden from sight. It was only above the twenty-four-foot level of brick lying that Brunelleschi decided to have the workers work on suspended external scaffoldings.

Figure 6. A model of the Brooklyn Bridge. The vertical stays carry the entire stress of the roadway.

For example, the weight of 4 million bricks got transferred by the curvature of the ***corda blanda*** (slack line) to the eight major ribs of the cupola. The slack line curvature acted as a ***garde fou*** preventing the bricks from falling inwardly before the masonry was set. Brunelleschi chose this catenary curvature because the cupola could not have been erected in any other way. Any other way would have been a disaster. Brunelleschi told the Wardens of Works: "Given the difficulties of this structure, Magnificent Lords Wardens, I find that you cannot in any way raise the cupola perfectly round, slice by slice, given that the upper plane where the lantern goes would be so large that the adding of that weight on it would destroy it immediately.” ***("Considerato le difficulta di questa fabbrica, magnifici Signori Operaj, trovo che non si pud per nessun modo volgerla tonda per-fetta, atteso che sarebbe tanto grande il piano di sopra, dove va la lanterna, che mettendovi peso rovinerebbe presto." Op. cit., vol. 2, p. 347. Da Opera; come sentiranno nella sua Vita scritta da Diversi.")***

The point is that if he had followed the strict rules of architecture known in his time, there would have been no way that Brunelleschi could have solved that problem. He had to break the rules across the board and change the axioms that prevented him from moving ahead to invent new ideas which lay in the future, and nowhere else. That is why, in any great enterprise, you must always start from the end, and never from the beginning. Anyone who starts a project from the beginning is a total fool and will never reach the end. This is the reason why Lorenzo Ghiberti was finally kicked out of the cupola project, because when he looked into the future, he could not see what Brunelleschi had in mind.

It is here that the catenary principle comes in as a creative mental function. The discovery of this principle comes from the projection into the future, as if from the infinite, and not from just what is hanging on two pegs in your backyard. It comes from the coincidence of the extremes, and not simply, as Aristotelians maintain, ***in medio stat virtus***. In other words, if you look for the solution to that problem in the past, or simply in the physical balance of a hanging chain, you will never find the solution. Only if you look for the solution by inverting the isoperimetric principle into its opposite negative curvature, will you have a chance to succeed, as Leibniz later did, with his construction of the true geometry of the catenary curve. Like Lyn said, the whole process is a matter of finding the transcendental idea first, and then, inverse the process from the top down:

> “We have to think, to do that, my point of reference is, we have to think about the galaxy: We have now discovered, and we have someone sitting here, who's been discovering it more than others, with the weather question, it's that you cannot separate the galactic processes from the earthly processes, from the Solar System processes; you can't do it! We find that Solar System effects are being influenced by galactic processes: You can't separate them. [inaudible]
>
> “Now, our problem as a human species, trying to deal with the future of life, human life, from the standpoint of the crises we see in our Solar System today, and by peering through the galaxy to discover that the galaxy a bit, and seeing that the galaxy and the Solar System are interconnected in ways we didn't appreciate before! We now recognize we're going to have to speak to the galaxy! Therefore, we have to look at our mental potential, or developable mental potential for dealing with the idea of the galaxy and its processes, from a human standpoint within the Solar System! […]
>
> “That's what we're dealing with: We have, in ourselves, we have the perception, as a precursor of the idea, and we have the ability to unleash that precursor, experimentally. And you do it in a form of exploration, like scientific exploration. You try to find the way, how is this going to work? How does this work? And you're driven, because you sense something there, like a dog smelling a bone, you know it's there, and you're going to find it! And you go on, and you're going to find it. And that's when you got a precursor of what you're going to think.”(Lyndon LaRouche, ***NEC Meeting***, Tuesday, Dec 27, 2011, page 14 and 19 of 50.) Now, let’s go back and study the different steps that Brunelleschi took to build his cupola.

2. THE ISOPERIMETRIC PRINCIPLE OF NICHOLAS OF CUSA AND THE POINTED FIFTH.

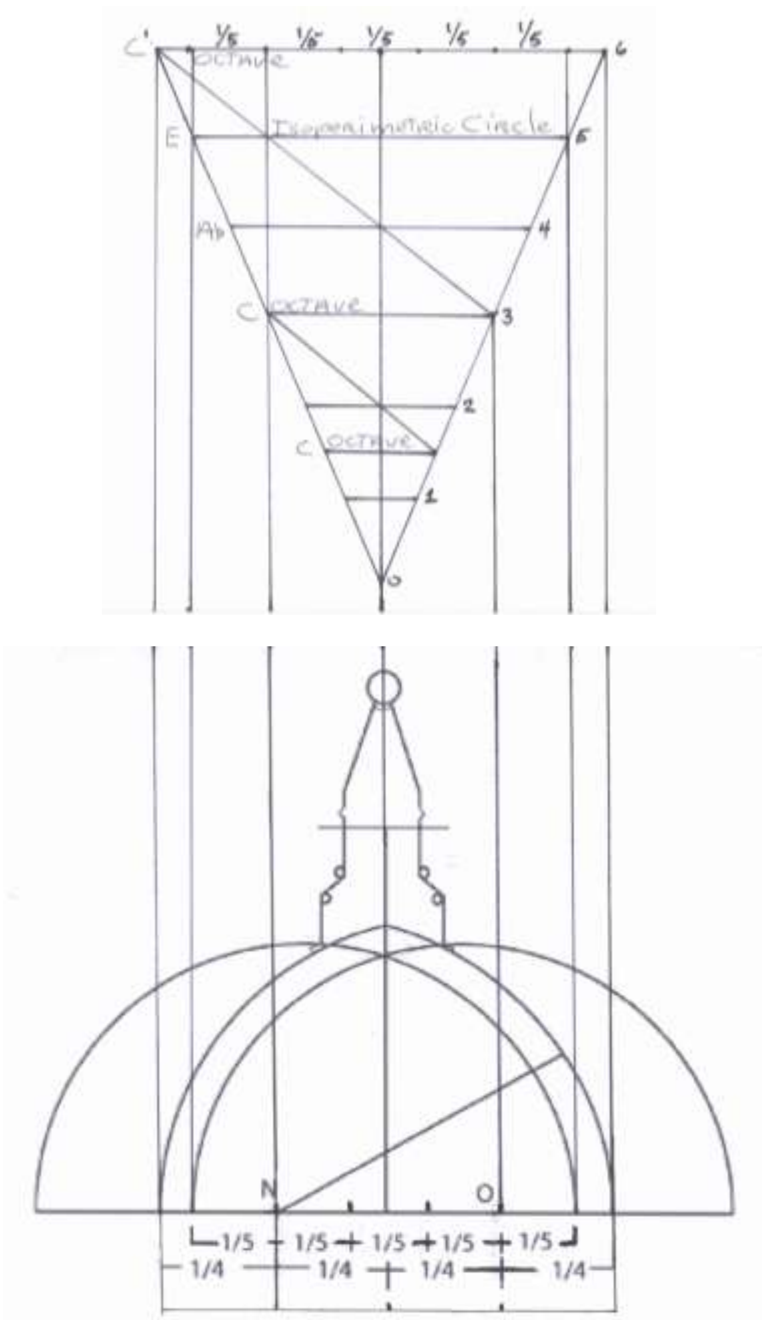

Figure 7. The profile of the "***quinto acuto"*** or the "pointed fifth" of the cupola is determined when the radius of curvature N of the internal Gothic arch is located at four-fifths of the diameter of the base. The same center of curvature N generates the outer shell as a "pointed fourth." If you project this Bartoli hypothesis from a cone, you will discover that the two shells resonate from Nicholas of Cusa's Isoperimetric Circle (6:5). (Lando Bartoli, ***La Rete Magica du Filippo Brunelleschi: la Seste, Il Braccio, le Misure***, Nardini, Florence, 1977. Also Nora Hamerman and Claudio Rossi, ***The Apollo Project of the Golden Renaissance***, Brunelleschi's Dome, 21st Century, July-August, 1989)

As I said, in order to solve the paradox of the Florentine cupola, Brunelleschi had to break with the axiomatic limits of positive curvature. The isoperimetric principle of Cusa was the principle that defined those limits as boundaries for all polygons and polyhedra. In its most elementary form, the principle stated that ***in the domain of elementary constructive geometry, the circle is the form of least action by means of which you can produce the largest area with the smallest perimeter***. This principle is also known as the least action principle of Sphaerics, because simple circular or spherical action produces the maximum amount of work with the least amount of rotational action. See my Lanternland exercises on this subject.

However, when a system of axioms, postulates and definitions reaches a limit and gets to a point where the system no longer functions, either that system is replaced by a higher principle of action, or the system will self-destruct under its own failure to change. A circular based cupola system, for example, is only valid within the limit of simple circular action of the Romanesque or Byzantine forms of architecture. But, what happens when you have a paradoxical situation like the Florence cupola which is based on both the octagon and the circle? Here, you have the isoperimetric paradox of Cusa. Strictly speaking, according to the axioms and postulate of Romanesque architecture, a Gothic dome cannot exist because it has a polygonal structure and circular structure at the same time. A dome cannot exist in Gothic architecture. It is a contradiction in terms. None of the European Gothic Cathedrals have domes. So, how do you solve the paradox of the Gothic Florentine cupola?

In April of 1989, I demonstrated the importance of this paradox by linking the curvature of the Brunelleschi cupola to the Isoperimetric Theorem of Nicholas of Cusa, because the two concepts caused a great dissonance, like a register-shift dissonance, within the well-tempered musical system. The two parts of **Figure 7** show how one can project the Gothic "pointed fifth" and "pointed fourth" of the Brunelleschi cupola from the top down, that is from the isoperimetric circle inscribed inside of a cone. Serving as the limit circle of all polygons, the isoperimetric circle of the cone also represents the limit of a paradoxical Gothic cupola.

You might want to ask: "Where is the dissonance of the axiomatic change located inside of the cupola?" Here, the shadows of the axiomatic singularity appear when you divide the cupola into a conical octave of three equal parts. The minimum circle C (3) represents the distance between two opposite radii of curvature N and O and the maximum circle C' (6) represents the outer circumference of the cupola. Between them are two other equal divisions, the isoperimetric circle E (5) represents the inside circumference of the cupola, and the harmonic circle Ab (4) represents the radius of curvature of the inner shell. What is the significance of these different harmonic components? What is the meaning of that special function of proportionality among the major third intervals of C- E, E-Ab, and Ab-C'?

Do the following experiment. Cut a cardboard circle and measure a string all around it. Then, take that string and tie the two ends encompassing that circle. Pin that circle onto a corkboard. Take the same string to make an equilateral triangle. Pin the triangle on top of the cardboard circle. They have the same perimeter (isoperimetric) but what difference of area do you find between them? They enclose different areas and one figure has angles while the other has none. The circle is the maximum area and the triangle is the minimum area for the same perimeter How do you solve that contradictory situation? This minimum-maximum relationship is expressed by the inscribed and circumscribed circles of the equilateral triangle. (**Figure 8** [1]). These are the minimum and maximum isoperimetric areas of all possible polygons.

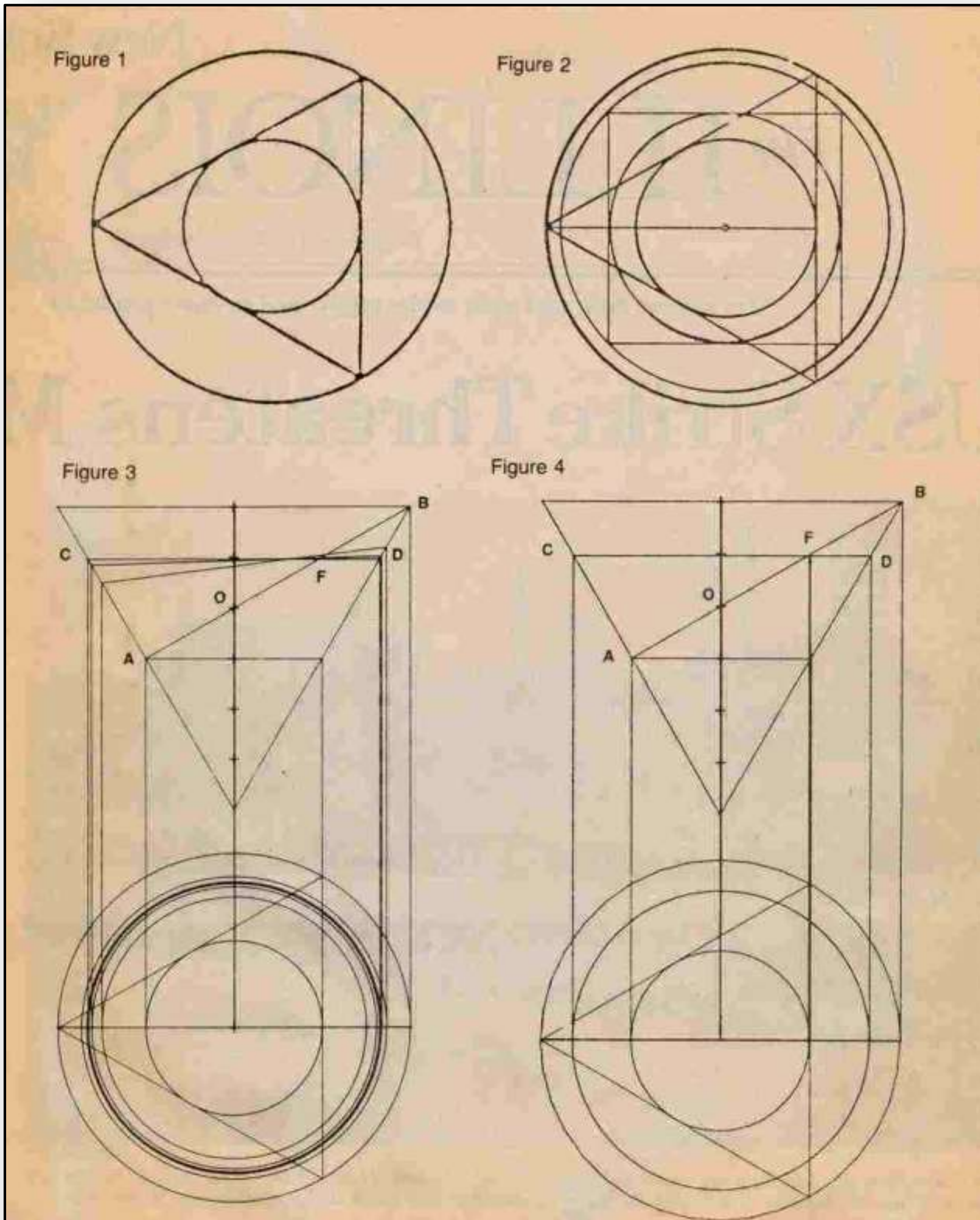

Figure 8. The conical projection of the Cusa Isoperimetric circle CD represents the limit of all inscribed and circumscribed polygons of the same-perimeter (iso-perimetric). The ideal circle which represents the limit of all of the polygons is the isoperimetric circle CD. The isoperimetric principle expresses the maximum amount of work for the minimum amount of action of positive curvature. Thus, the unique nature of the circle is to be the largest area enclosed by the smallest perimeter.

Next, take the same string and make an isoperimetric square out of it. Note the increasing inscribed circle and the decreasing circumscribe circle [2]. Then generate the same circles for a pentagon, a hexagon, and so forth until you get to the octagon, which is the shape of the cupola base. All of the inscribed and circumscribed circles of such polygons will tend toward a limit area which is the area of the isoperimetric circle CD [3]. Moreover, that limit will never be reached because polygons can never become a circle. The question is: how do you go beyond that axiomatic limit? How do you break the axiomatic barrier between the polygon and the circle? That is the type of problem that Brunelleschi had to solve and discover a new principle before lying the first brick to erecting his cupola. The two circles B and CD represent the location of the two shells of the cupola. [4]

3. BRUNELLESCHI'S EGG AND THE FUNCTION OF AXIOMATIC CHANGE

Although there is no written record that Brunelleschi or Cusa left about this perplexing cupola paradox, their common way of thinking is sufficient evidence to say that they had a community of mind that reflected the same temperament for problem solving. Furthermore, they were both associated with Paolo Toscanelli with whom they both had the opportunity to have lengthy discussions on music, geometry, theology, and astronomy. Vasari reported on the complexion of that state of mind in his beautiful first book on the lives of artists, and he made the appropriate point on the curvature of Brunelleschi's mind. This is how Vasari characterized the axiom busting effect that the Brunelleschi catenary principle and the Cusa isoperimetric principle had on the Consuls and the Wardens of Works responsible for the Florence Cathedral:

> "By the year 1420, all these ultramontane masters were finally assembled in Florence, and likewise those of Tuscany and all the ingenious craftsmen of design in Florence; and so Filippo returned from Rome. They all assembled, therefore, in the Office of Works of S. Maria del Fiore, in the presence of the Consuls and of the Wardens, together with a select body of the most ingenious citizens, to the end that these might hear the mind of each master on the question and might decide on a method of vaulting this tribune. Having called them, then, into the audience, they heard the minds of all, one by one, and the plan that each architect had devised for that work. And a fine thing it was to hear their strange and diverse opinions about the matter, for the reason that some said that piers must be built up from the level of the ground, which should have the arches turned upon them and should uphold the wooden bridges for sustaining the weight; others said that it was best to make the cupola of sponge-stone, to the end that the weight might be less; and many were agreed that a pier should be built in the centre, and that the cupola should be raised in the shape of a pavilion, like that of S. Giovanni in Florence. Nor were there wanting men who said that it would have been a good thing to fill it with earth mingled with small coins, to the end that, when it had been raised, anyone who wanted some of that earth might be given leave to go and fetch it, and thus the people would carry it away in a moment without any expense. Filippo alone said that it could be raised without so much wood-work, without piers, without earth, without so great expenditure on so many arches, and very easily without any framework.

“It appeared to the Consuls, who were expecting to hear of some beautiful method, and to the Wardens of Works and to all those citizens, that Filippo had talked like a fool; and deriding him with mocking laughter, they turned away, bidding him talk of something else, seeing that this was the plan of a madman, as he was. Whereupon Filippo, feeling himself affronted, answered: "My Lords, rest assured that it is not possible to raise the cupola in any other manner than this; and although you laugh at me, you will recognize, unless you mean to be obstinate, that it neither must nor can be done in any other way. And it is necessary, if you wish to erect it in the way that I have thought of, that it should be turned with the curve of a quarter-acute arch, and made double, one vault within, and the other without, in such wise that a man may be able to walk between the one and the other. And over the corners of the angles of the eight sides the fabric must be bound together through its thickness by dove-tailing the stones, and its sides, likewise, must be girt round with oaken ties. And it is necessary to think of the lights, the staircases, and the conduits whereby the rain-water may be able to run off; and not one of you has remembered that you must provide for the raising of scaffoldings within, when the mosaics come to be made, together with an infinite number of difficulties. But I, who see the vaulting raised, know that there is no other method and no other way of raising it than this that I am describing." And growing heated as he spoke, the more he sought to expound his conception, to the end that they might understand it and believe in it, the greater grew their doubts about his proposal, so that they believed in him less and less, and held him to be an ass and a babbler. Whereupon, having been dismissed several times and finally refusing to go, he was carried away bodily from the audience by their servants, being thought to be wholly mad; and this affront was the reason that Filippo could afterwards say that he did not dare to pass through any part of the city, for fear lest someone might say: "There goes that madman."

“The Consuls remained in the Audience Chamber all confused, both by the difficult methods of the original masters and by this last method of Filippo's, which they thought absurd, for it appeared to them that he would ruin the work in two ways: first, by making the vaulting double, which would have made it enormous and unwieldy in weight; and secondly, by making it without a framework. On the other hand, Filippo, who had spent so many years in study in order to obtain the commission, knew not what to do and was often tempted to leave Florence. However, wishing to prevail, he was forced to arm himself with patience, having insight enough to know that the brains of the men of that city did not abide very firmly by any one resolution. Filippo could have shown a little model that he had in his possession, but he did not wish to show it, having recognized the small intelligence of the Consuls, the envy of the craftsmen, and the instability of the citizens, who favored now one and now another, according as it pleased each man best; and I do not marvel at this, since every man in that city professes to know as much in these matters as the experienced masters know, although those who truly understand them are but few; and let this be said without offence to those who have the knowledge. What Filippo, therefore, had not been able to achieve before the tribunal, he began to effect with individuals, talking now to a Consul, now to a Warden, and likewise to many citizens; and showing them part of his design, he induced them to determine to allot this work either to him or to one of the foreigners. Wherefore the Consuls, the Wardens of Works, and those citizens, regaining courage, assembled together, and the architects disputed concerning this matter, but all were overcome and conquered by Filippo with many arguments; and here, so it is said, there arose the dispute about

> the egg, in the following manner. They would have liked Filippo to speak his mind in detail, and to show his model, as they had shown theirs; but this he refused to do, proposing instead to those masters, both the foreign and the native, that whosoever could make an egg stand upright on a flat piece of marble should build the cupola, since thus each man's intellect would be discerned. Taking an egg, therefore, all those masters sought to make it stand upright, but not one could find the way. Whereupon Filippo, being told to make it stand, took it graciously, and, giving one end of it a blow on the flat piece of marble, made it stand upright. The craftsmen protested that they could have done the same; but Filippo answered, laughing, that they could also have raised the cupola, if they had seen the model or the design. And so it was resolved that he should be commissioned to carry out this work, and he was told that he must give fuller information about it to the Consuls and the Wardens of Works. (Giorgio Vasari, LIVES OF THE MOST EMINENT PAINTERS, SCULPTERS, AND ARCHITECTS, Volume I, trans. Gaston Du C. De Vere, Publisher to the Medici Society, Limited, London, 1912, p. 207-209)

What Vasari described at length is nothing less than the process of an axiomatic change. How can an egg stand up by itself? This is also how Leibniz discovered the principle of construction for the catenary curve a few centuries later. Leibniz didn't use an egg for his demonstration, but he perplexed everyone in a similar way when he explained his anti-Euclidian approach by way of what he termed the "method of inversion of tangents." The function of an axiomatic change is to render someone perplex and make him discover his former state of stupidity. An axiomatic change shows the stupidity of all fixed rules. For Brunelleschi's idea to stand up, its construction also had to start from the end and be established from the top down without external support.

Euclid would say: "***Given a circle, find the tangent."*** That problem was very easy to solve, because the circle is given ***a priori***, so, you can easily find a tangent. But, Leibniz started from the end and did the inverse: "***Given the tangent, find the curve***." People said: "That is crazy! It is like putting the carriage in front of the horse. How can you draw a tangent if you don't have the horse to tie it on?" That problem is much more difficult to solve, because the curve is not given ***a priori***, and your mind had to be oriented ahead into the future to discover some transcendental curve that does not yet exist. What Leibniz was actually looking for was the curvature of physical space-time, but that is moving ahead, too quickly.

Brunelleschi confronted the Consuls and the Wardens with a similar impossible situation that required the discovery of a completely new physical principle that did not yet have any existence. He was, in fact, telling them: "***Given that nothing from the past will work, I must apply a new universal physical principle from the future***." Brunelleschi told them: "The two vaults of the cupola must be built as I described, without framework, up to a height of sixty feet, and from there on in whatever way the builders decide, since experience shows what has to be done." (Georgio Vasari, ***Lives of The Artists***, Volume I, Penguin Classics, 1965, p. 148.) This was so perplexing that it was the equivalent of saying: ***"I will bring you halfway to Mars, and then, experience will teach you how to travel the rest of the way!"*** The Cathedral Committee was not convinced on that matter of principle, and they required more explanations and demonstrations on the security system that Brunelleschi had devised.

So, Brunelleschi explained to the Wardens of Works in detail how he would elevate eight great ribs of stone which would arch in accordance with the fifth and the fourth and be secured at the top. These ribs, in the form of an octagon, would be erected and tuned simultaneously in congruence with two almost concentric and dissonant curved membranes of masonry (the outer shell in a ratio of 3:4 and the inner shell 4:5). As shown above, these double ratios of the two vaults, 3:4 and 4:5 resonate with Cusa's isoperimetric ratio of 6:5. As Gentry and Lesniewski put it in their short study of the Duomo:

> "Brunelleschi had a command of materials and construction techniques but also a strategy for "geometric control." Had the dome been built with framework, the overall form of the dome could have been confirmed on the formwork before the start of laying the brick. With construction ***sans armadura***, it became critical to have a repeatable method for checking the placement of the bricks course by course. Obviously, the standard mason's string would not work for Brunelleschi because the masonry is moving around in polar octagonal array and is bedded on the slack -line. In addition, it is important to remember that the cupola was constructed before the development [of] optical instruments or even measuring tapes. All geometry was controlled by spirit levels, straight edges, templates, strings, and sight lines.
>
> "Many scholars have puzzled over the methods used to control the geometry during construction [Mainstone 1977, Mainstone 1998, and Coombs 2001]. The dominant interpretation is that a series of control points and strings were used to establish each brick course. The beauty of this method is that it would have simultaneously controlled the position of the eight corner spurs which established the "pointed fifth," the declination of the masonry bedding towards the central axis of the dome, and the slack-line.
>
> "Each of the eight spurs or ribs is a segment of a circular arch, thus the "pointed fifth," so a simple string could have been used to establish the arc. According to this idea, Brunelleschi used a pair of equal-length strings to maintain a proper plane of the arc for each rib. He then placed iron rings in the masonry of the drum to act as permanent benchmarks for these strings." (T. Russell Gentry and Anatoliusz "Tolek" Lesniewski, "STRUCTURAL DESIGN AND CONSTRUCTION OF BRUNELLESCHI'S DUOMO DI SANTA MARIA DEL FIORE.")

These three short paragraphs contain almost all that one needs to study in order to understand the engineering aspect of Brunelleschi's cupola. For extra security, the entire arrangement was to be surrounded by four chains of masonry and timber clamped together with plates of iron and surrounded by iron chains. According to Brunelleschi's own account, he also required "a chain of iron over the timber," ***(in su detti quercie una catena di ferro)*** which would "bind the ribs and hold the vault inside" (***che le-ghino i detti sproni e cingano la volta dentro***). (Vasari, ***Le Opere di Giorgio Vasari***, Milanesi edition, Florence, 1880, Vol. 2, p. 337.) This is what finally convinced the Wardens of Works.

Like in a living being, the ribs would extend through the entire thickness of the two membranes and would secure the two shells of the dome like the ribs of a body unite the outer region of the muscles with the inner region of the organs by uniting positive curvature with negative curvature. Between each pair of 8 ribs, Brunelleschi added two smaller ribs with ten horizontal circles of masonry passing through them, as in Dante's ten heavenly circles: thus, 8 great ribs and 16 smaller ribs for a cage with a total of 24 ribs, a ratio of circle to rib that is 5:12.

4. THE CUPOLA, THE DOUBLING OF THE CUBE, AND THE GREAT PYRAMID.

"The reason why you have difficulties in understanding negative curvature is because it's always in your face."

Dehors Debonneheure

Let us get back, one last time, to the conceptual unity of effect in the construction of the pointed profile of the cupola. Aside from being structurally and esthetically essential, the musical ratios for the inside and outside shells are the crucial key shadows of curvature of the cupola. The internal Gothic arch ratio of the ***quinto acuto*** (pointed fifth) was an absolute condition established in 1376 by the Wardens of Works. Brunelleschi had to abide absolutely by this criterion and used it as a guide function throughout the construction of the great work. Ironically, however, this criterion was of the same proportionality as the doubling of the cube discovered by Archytas and the same proportionality as found in the Great Pyramid of Egypt. Is this merely a coincidence or are we confronted, here, with a community of principle? Time will tell.

The answer to that question might be found in the catenary property that reflects the transcendental function of inversion, since it is an architectonic principle which pulls new creative ideas from final causality into the real world. This is what Leibniz had also identified as a constructive geometrical method that functions by inversion of tangents. Here, this inversion process is best reflected by the increase in energy flux-density from the Middle Age to the Renaissance; that is, the passing from a lower form of existence to a higher form of existence. The construction of the Great Pyramid encountered a similar situation in Ancient Egypt. Moreover, one also has to make an axiomatic leap from the plane to the solid in order to discover the proportionality for the Archytas doubling of the cube. Such inversions are always necessary to go beyond what appears to be impossible from the standpoint of previous axiomatic standards. The same occurs in any historical period of axiomatic change.

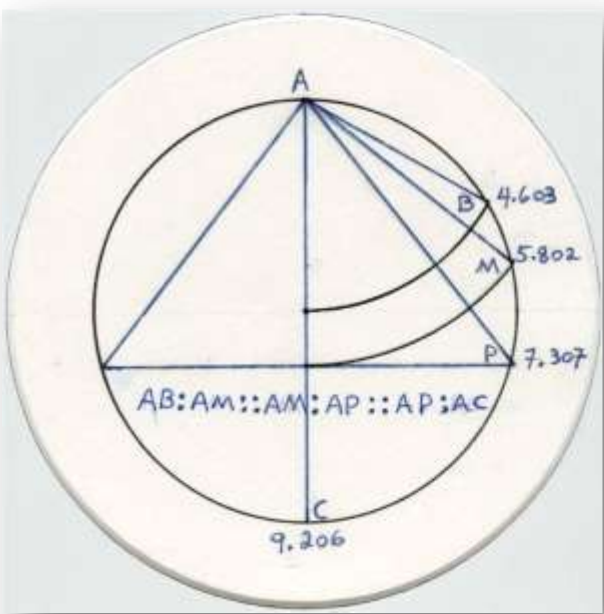

Figure 9. Application of the Archytas doubling of the cube to the profile of the Great Pyramid of Egypt. The proportionality of the Great Pyramid profile and the Brunelleschi cupola are the same! Cube the indicated lengths of each of the four segments AB, AM, AP, and AC and you obtain a series of cubic values that are the doubles of one another in the indicated proportionality.

Why are the values of the Brunelleschi cupola congruent with the profile of the Great Pyramid of Egypt and with the method for doubling the cube by Archytas? What is the significance of that strange coincidence? Well, the answer is not difficult to find. All three discoveries have the same proportionality, and all three are derived from the triply-connected series of major thirds in the well-tempered system. Although they may not be directly related to voice register shifts, those major thirds represent the fundamental principle of a mental resonance underlying those three very unique but different axiomatic discoveries.

Therefore, project this proportionality into the doubly-connected manifold of the pathway of our solar system inside of our galaxy, for example, as if it were a torus that gave birth to the spiral galaxy. Establish the Poloidal: Toroidal relationship in the ratio of 5:12 with a total of eight octaves holding the system together. This is like the Brunelleschi rings around the cupola. Next, consider the locus where the positions of those major thirds fall by jumping over intervals of four half-tones between each of them. What do you find? The same partitioning as the cupola displays, between 4 and 5. In this torus configuration, the major third intervals are all systematically alternating the tension and compression from both the outside and the inside of the Torus; that is, between positive and negative curvature. This metaphor demonstrates that all three discoveries pertain to a doubly-connected manifold.

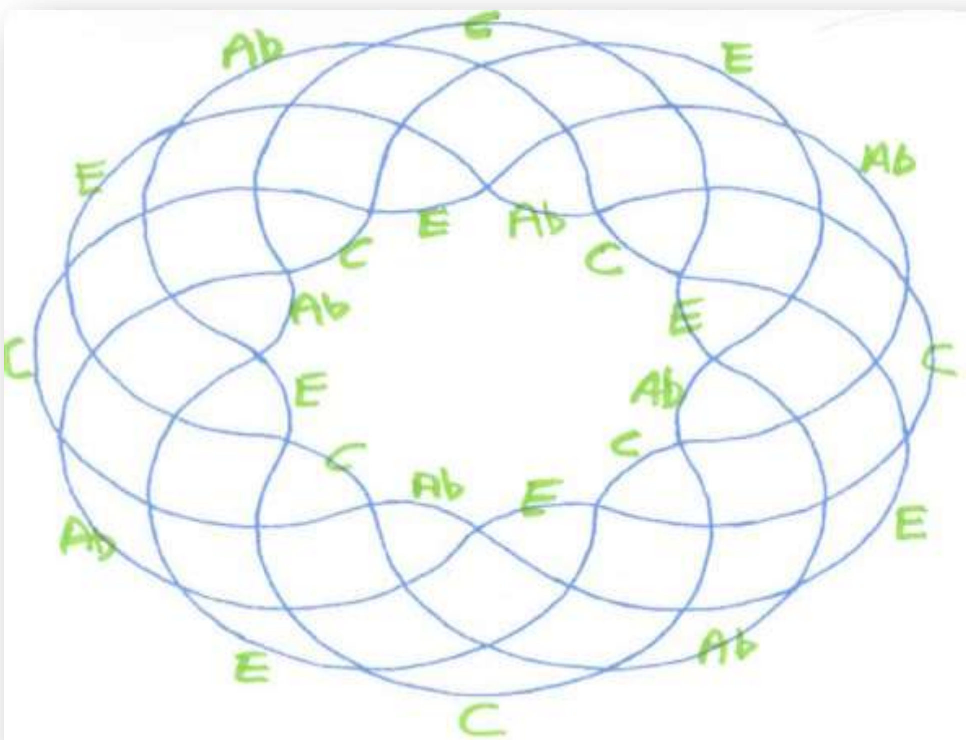

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Figure 10. An **eight-octave-physical-space-time-modular-wave-function** expressing the common proportionality between the Brunelleschi cupola, the Archytas doubling of the cube, and the Great Pyramid of Egypt. The Poloidal:Toroidal ratio is 5:12.

5. CUSA'S CONSENT OF THE WILLING AND THE SELF-GOVERNING PRINCIPLE.

In 1438, the most crucial idea that Cusa developed for the unity of the Church at the Council of Florence in Ferrari was based on the principle of self-government in human society; that is to say, precisely the opposite to the current British concoction of "governance." Brunelleschi considered this principle essential for the successful erection of his cupola. So, his question was: "How do you apply a principle in which both the parts and the whole are self-supporting?" The idea is that each and every stone and brick must be organized according to a principle whereby they are all kept in place by their mutual compressions and tensions, brought together by the interplay of their weights, positions, and sizes, as in a well ordered human society based on the government of the people, by the people, and for the people.

Once the process is completed, each of those bricks is under compression and tension by two different principles, the isoperimetric principle of positive curvature and the catenary principle of negative curvature, but whose complementarity and congruence assume the character of the self-governing principle of Cusa's "consent of the willing." Therefore, a cupola based on those two principles combined becomes self-governing. That is the sort of catenary construction that is relevant for a new form of galactic thinking based on thermonuclear fusion, today. The most significant aspect of the Brunelleschi challenge of Santa Maria Del Fiore was not the cupola as such, but the galactic principle by means of which that cupola was constructed. As Lyn put it:

> "This connection is illustrated with exemplary appropriateness by a case I have often referenced since 1988, the lesson to be adduced from Brunelleschi's successful construction of the famous cupola of the Santa Maria del Fiore Cathedral of Florence. I continue to emphasize that example, not merely because I succeeded, during 1987-88, in rediscovering a principle which Brunelleschi had used, with his foreknowledge of its success, in effecting a process of construction which had been thought physically impossible. The principle he used to secure that success, was the same catenary principle which Leibniz, more than two centuries later, was first to identify as the expression of the universal principle of physical least action. Here, art and science were the same principle. The otherwise impossible process of construction so effected, was a demonstration of the principle of truth expressed equally as a principle of truth in the triumph of Christian Platonic science and art, over the false, pantheonic tradition and symbols of Latin Romanticism.
>
> "Leibniz's principle of least action, which is the basis for Leibniz's discovery of natural logarithms, is expressed by the catenary function, which is the physical curve of "the hanging chain," caused by physical action. This curve was reflected in ancient, pre-Roman Classical Greek sculpture as the principle of continuing motion caught in a midstream moment, as John Keats calls our attention to this equivalence of truth and beauty in his "Ode to a Grecian Urn."
>
> "Once again: Truth is a matter of method! In this case, the cupola, truth as a method of art, and truth as uniquely a method of physical principle for successful construction, coincide. To succeed in sculpting a figure caught in mid-motion, the mind of the sculptor must feel the impact of what Leibniz defined as a universal physical principle of least action, just as Brunelleschi settled upon the use of the catenary, in the form of a hanging chain, a form of matter in motion

even when it appears stilled, to enable the process of constructing the double wall of the cupola. The point was not that the finished cupola reflected the catenary form, but that the ability to construct those walls depended upon the principle of action expressed during each and every momentary phase of the ongoing process of construction of the still yet to be completed cupola." (Lyndon H. LaRouche, Jr., "***Believing Is Not Necessarily Knowing***," *Executive Intelligence Review,* Jan. 17, 2003 (Vol. 30, No. 2).

To illustrate the truth of what Lyn is saying consider that four sets of stone chains were embedded into the masonry and acted as catenary tension chains containing the compression thrust of the Cupola internally absorbed by the tension from the inner and outer shells spiraling action all the way up from the lantern. It is such a spiraling least action that is pulling the whole cupola upward. The purpose of that design is to resist the outward thrust tendency at four different levels of the Cupola, where chains are acting like three divisions of the musical octave. The same catenary principle was applied continuously at 90 degrees to each layer of the bricks between each rib, and following the continually changing angle of the masonry slope from zero degrees at the base to about sixty degrees at the top.

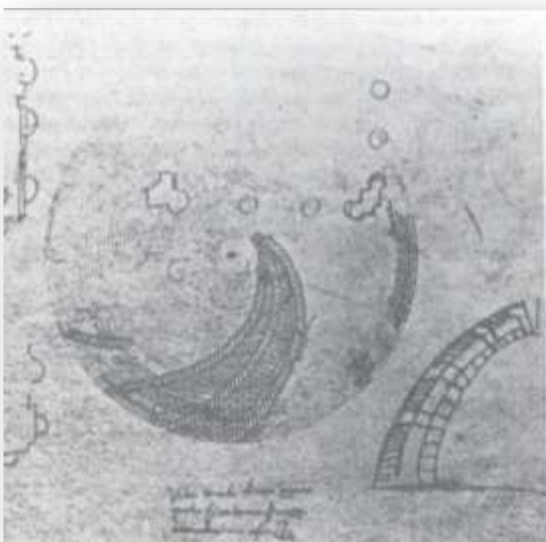

Figure 11. The catenary herringbone curvature of the Cupola. (Uffizi Museum, Florence. L. Bartoli, ***La Rete Magica del Brunelleschi***, 1977, p. 80.)

The herringbone pattern of brick lying following the catenary curve of the slack-line generated the effect of a negative curvature that caused the gravity of the bricks to be contained by a series of layers mounted, one on top of the other, without external support. The secret was located in the series of continuously shortening courses of bricks that were laid horizontally in a spiral fashion with two book-end vertical bricks holding them like "clamps" (***morse***) at each end, thus, making each layer self sustained as if they were pulled from above by the spiraling motion under the lantern that wasn't even in place yet. The herringbone structure knitted such a pattern that it created an effect of negative curvature which neutralized the counter weight of positive curvature. In this fashion, each brick was able to carry its share of the tensile and compressive stress of the dome as a whole. The two curvatures did not cancel each other out; they fused together to give the cupola greater power. This was entirely coherent with Brunelleschi's double "pointed forth" and "pointed fifth," with the inversion of the Cusa Isoperimetric circle whose dissonant 4:5 and 3:4 center of curvature is located at the base of the Dome.

Again, the catenary, here, should not be considered simply as a chain or a technique. It is not a thing, it is a PRINCIPLE. And, in that sense, the catenary principle is a self-sustaining, and self-supporting principle of architectonic gravitation without the use of a framework. Such an axiom busting discovery, therefore, is a principle by means of which the human mind, when confronted by a perplexing and apparently impossible situation, is always capable of discovering a solution by inversion, that is, by turning a crisis into an opportunity, ahead of time. The point of principle to be made with the Brunelleschi cupola is that no one with practical common sense would have undertaken to build such a great dome on top of an already erected wall. But, Brunelleschi had more than common sense; he had the entire constructive geometrical scheme in his mind before he started.

6. THE GOTHIC VAULT PARADOX AND THE RESONANCE OF THE PAZZI CHAPEL.

Now, let us look at the case of the small chapel of the Pazzi family in the cloister of Santa Croce in Florence. The small chapel was begun in 1441 for the purpose of training monks to sing in the Bel Canto method. The main characteristic of the Pazzi Chapel is that it is a musical anomaly created for Bel Canto. It is a simple rectangular plan with a square sanctuary in the center which is covered with a circular Gothic vault (not a dome). (See **Figure 12**.)

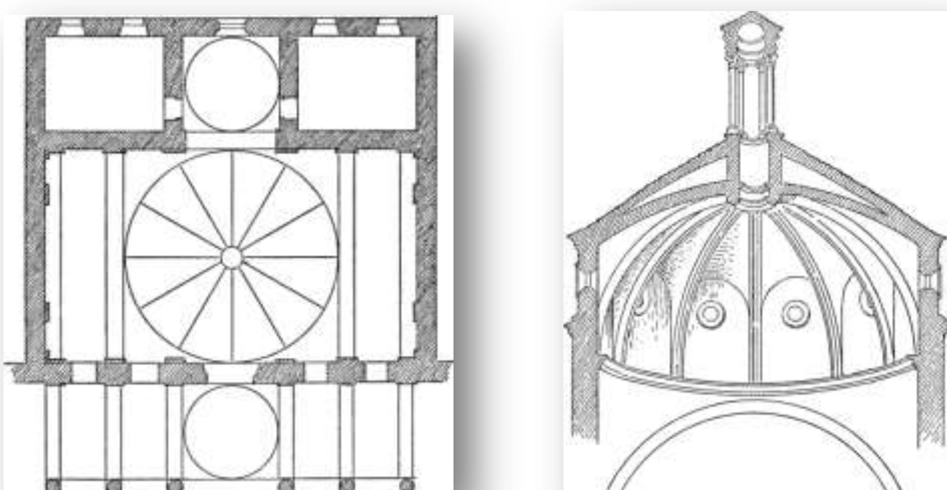

Figure 12. Plan and elevation of the vault of the Pazzi Chapel. (Charles Herbert Moore, ***Character of Renaissance Architecture.***)

The twelve apse vaults rest on a cylindrical drum covered with a low-pitched slightly curved roof of masonry supporting a lantern. The double vault of the roof is completely different from the double cupola of the Duomo, but it is similar in the fact that the whole scheme is a dissonant singularity that is mixing Byzantine-Roman and Gothic architectures, a scheme that exists nowhere else in the world. Thus, the paradox of what some writers have identified as the impossible "Gothic dome." The paradox lies in the fact that, strictly speaking, a dome cannot exist in the Gothic order, because the thrust of a Gothic arch is everywhere discontinuous on the abutments, while the thrust of a Roman-Byzantine dome is everywhere continuous on the circular base. Here you have the two in one.

Figure 13. The Pazzi Chapel interior. (1441-1460)

In the Pazzi vault, Brunelleschi integrated both principles where the vault is both Gothic and spherical. Again, by doing this, he broke the rules of the traditional Romanesque-Byzantine orders. It is the classical Gothic design of the vault clashing with the structural Byzantine system which causes the dissonance, and which establishes the unique resonance of the cupola. The apparent awkward result of this improper mixture of three different architectural orders is precisely the singularity that Brunelleschi was looking for and that most classical architects considered "irrational" and even "barbarian." This apparent "irrationality," however, is precisely what made the genius of this little gem of architecture, because it broke all of the rules of the game and created a higher resonance. The result is Bel Canto.

For instance, the resonance of the vault in the Pazzi Chapel is made up of deep voussoirs which are held by twelve ribs corresponding to the twelve intervals of the well tempered musical system. These voussoirs act as echo chambers of positive and negative curvatures which reverberate into their resonating cavities and amplify the sound waves of musical notes that are emitted from the voice of singers standing on the floor below.

This means that the Pazzi Chapel resonates like the cranium of a Bel Canto singer. All of the cavities of the head of a Bel Canto singer are harmonically organized to focus certain musical sounds and amplify their resonance in a well-tempered manner by increasing the energy-flux density of the voice into elevating it to a higher register. The chapel works on the same principle. They are not built in the same way, but they are capable of reproducing the same resonance of axiomatic change. That is the most fascinating aspect of the discovery of Brunelleschi for the Pazzi Chapel interior as well as for the Florence cupola.

CONCLUSION: THE FLORENCE CUPOLA AND THE MISSION OF AMERICA.

After the Duomo had been completed and the Lantern had been erected in 1461, the greatest astronomer of the Quatrocento and the best friend of Brunelleschi and Cusa, Paolo Toscanelli, used the Lantern of the Florentine Cathedral to realize the most important astronomical experiments that led to the discovery of America. As historian Ross King reported: "For in 1475, inspired by the height of the dome, Toscanelli climbed to the top and, with the blessing of the Opera del Duomo, placed a bronze plate at the base of the lantern. This was designed so that the rays of the sun would pass through an aperture in its center and fall some 300 feet to a special gauge on the floor of the cathedral, a stone inlaid in the Chapel of the Cross. Santa Maria del Fiore was thus transformed into a giant sundial." (Ross King, ***Brunelleschi's Dome***, Penguin Books, New York, 2000, p. 148.)

To most of the citizens of Florence who had seen or heard of the experiment, Toscanelli was merely calculating with more accuracy what most astronomers of the past had done before him; that is, determining the precise moments of the summer and winter solstices and the fall and spring equinoxes. That was the official version. However, little did those citizens suspect that Toscanelli was much more far-sighted and was, in fact, using the lantern as the beacon that would light up the galactic pathway to America.

Sitting in the Brunelleschi lantern and following the plan of his closest friend, Nicholas of Cusa, Toscanelli began to trace the least action principle that would lead him to the New World through a celestial pathway. I say "celestial" because the way to America was not discovered by mapping the seas of the globe, but by mapping the sphere of the heavens onto the globe of the Earth. The same inferential irony applies to the Brunelleschi cupola as it was built from the top down. Furthermore, the discovery is not how the cupola was erected, but how your mind works with respect to Brunelleschi's problem solving method of changing the mental curvature of physical space-time. Don't forget, like the galaxy, the Brunelleschi cupola is a state of mind.

While some of Toscanelli’s discoveries served the ecclesiastical purpose of determining precise dates for the celebration of religious events, his measurements were also intended for a far greater purpose. Toscanelli’s intention was the same as Cusa’s and Brunelleschi’s: bring the anti-oligarchical Renaissance from Europe into America. Thus, while everyone around him was sleeping or trying to build cupolas with practical means, from the bottom up, Toscanelli was studying the night sky and mapping the pathway to go to India and China by mapping a precise route through the galaxy and using the western route of the Atlantic Ocean as a short cut through America. The age of celestial navigation by Astrolabe had taken root in Europe. While backward Europeans were still using the Mediterranean as their local lake without even using the function of longitude and latitude, Toscanelli was restoring the lost Islamic tradition of the Astrolabe as an instrument of navigation across the seas of the globe by measuring the angles of the stars. This is how Toscanelli joined Brunelleschi and Cusa into showing the way to a higher state of existence by means of azimuths and almucantars.

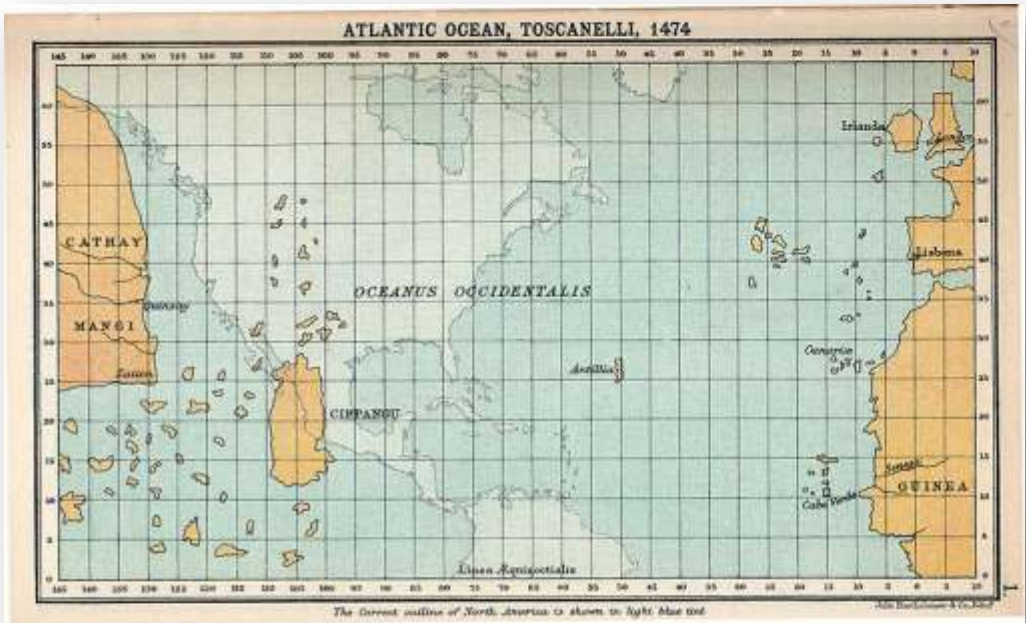

Figure 14. A modern version of the Toscanelli map (1474) that Columbus used during his four voyages to the New World. Note the location of the added blue contour of the American Continents.

Toscanelli gave his new map of the world (**Figure 14**) that indicated the shortest route to India and China via the Atlantic Ocean to Christopher Columbus at the beginning of the 1480’s. It is reported that Columbus used Toscanelli’s map in all four of his voyages to the New World. Although Columbus claimed he did not use any maps to travel to America, Ross King added this final touch of irony about the function of the cupola “…it is to be wondered if Europeans would have landed in the New World quite so early and so easily without the maps and tables that Paolo Toscanelli compiled with the help of his observations taken from the dome of Santa Maria del Fiore.” (King, Op. Cit., p. 152.)

It was in that sense that Christopher Columbus took the same axiomatic route in time, as did Imhotep, Archytas, Cusa, Brunelleschi, and Toscanelli, and in doing so, he accelerated history. Because this is what the American mission of Cusa meant to him, to be ahead of his time. His mission was man's freedom from restriction and limitations of oligarchical clock-time, and the first and most important limitations he had to deal with was the axiomatic mental changes that occurred in the real physical space-time of his mind. That is the reason why the curvature of the cupola, the doubling of the cube, and the Great Pyramid of Egypt are proportional to the same state of mind, because the curvature of their time is the proportionality of change that must be drawn from the extraterrestrial and immortal imperative of man. Such discoveries transcend oligarchical clock-time through that proportionality because the curvature of their discoveries was meant to use physical space-time as a measure of change. Those men were ahead of their time because time led them into flexible proportionality of curvature change. This is how change in the proportionality of curvature turns out to be the real clock that runs the universe. Time is not only relative, but also gravity flexible. As they say: "When you start from the end, the future ain't what it used to be!" Just to provoke a bit of galactic thinking, in ending, here is the metaphor I would suggest you think about when you look at the Brunelleschi cupola from the top down.

" <u>DISTANT RING OF STARS FOUND CIRCLING THE MILKY WAY</u> – SDSS SEATTLE – 6 January, 2003 – A team of scientists from the Sloan Digital Sky Survey has discovered a previously unseen band of stars beyond the edge of the Milky Way Galaxy."

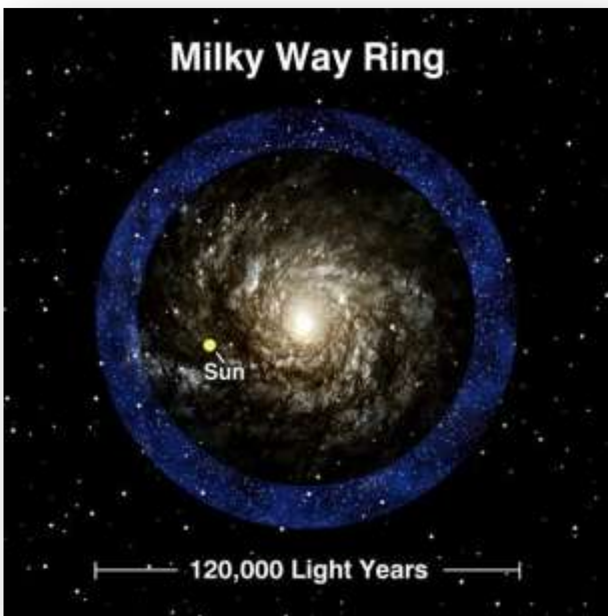

Figure 15. "This ring around the Milky Way Galaxy discovered by the Sloan Digital Sky Survey may be what's left of a collision between our Galaxy and a smaller, dwarf galaxy that occurred billions of years ago. It's an indication that at least part of our galaxy was formed by a lot of smaller or dwarf galaxies mixing together, explained investigators Heidi Jo Newberg of Rensselaer Polytechnic Institute and Brian Yanny of the Fermi National Accelerator Laboratory's Experimental Astrophysics Group. CREDIT: Rensselaer Polytechnic Institute and the Sloan Digital Sky Survey (www.sdss.org)"

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