Leibniz and the Stradivari Violin—Or, the Contrapuntal Dance of Beauty and Truth

by David Shavin

The June 22, 2018 issue of EIR *covered the 1696 contest over Leibniz's second transcendental curve, the brachistochrone, and Isaac Newton's bizarre response, in the article, The Case of Sir Isaac Newton—or, What Was God Thinking? This present story, insofar as it deals with the birth of the transcendental curves, may be considered a "prequel."*

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Gottfried Wilhelm Leibniz (1646-1716)

July 26—When Gottfried Leibniz was confronted with developing a strategy for Peter the Great's Russia, his mind went for, what to him was, the obvious: European culture and Chinese culture were peculiar bookends of the whole Eastern hemisphere. So, of course, Russia could have no better, or more lawful, strategic mission than to maximize the world's development by conjoining these separate cultures into something qualitatively superior to Europe, China or Russia, separately. Leibniz's mind insisted upon going to the highest level necessary to find where a beautiful idea cohered with a truthful idea.

Today, beyond the bankrupt and dirty geopolitical thinking of the recent decades, there exists the imminent, objective possibility of exterminating world poverty, turning deserts into gardens, and earth-forming the moon. No matter how often this technological capacity can be shown, an underlying and unnatural cynicism, born of decades of submission to ugliness, persists in Western culture-with words and looks to the effect of "But, you know, it is never going to happen." The emotionally blunted response may acknowledge some abstract moral duty to wipe out poverty, but the excitement and joyful anticipation of such a mission is strangely absent. However, it is a beautiful mission. We may actually have to get happy about the work ahead.

We, today, are challenged, then, to be inspired by beauty so as to fight to locate and realize the underlying truth of what is possible, and now, quite necessary. It is to that end that we examine a curious few weeks that Leibniz spent in Florence, Italy, and the amazingly beautiful and truthful fruits of those few weeks. This is the never-before told story of Leibniz's role in the birth of both the beautiful, lased, "bel canto" Stradivarius violin, and the powerful scientific family of transcendental curves.

Leibniz in Florence

Leibniz, age 43, visited Florence, Italy, in November and December, 1689. He had sufficient time to appreciate, and be inspired by, the Santa Maria del Fiore Cathedral and its famous dome (cupola).[1] Leibniz gave classes, on his new developments in physics and his methods of analysis, to the two sons of the Medici Duke, Cosimo III, and to their tutor, Baron Rudolf Christian von Bodenhausen. The classes went quite well, and Leibniz entrusted to Bodenhausen's care his manuscript copy of *Dynamica et potentia*, to be prepared for publication by Bodenhausen. Within seven months of Leibniz's viewing of that cupola, for which the catenary curve plays a major role, Leibniz announced that he had solved the historic catenary puzzle.

Detail from Raphael's "The Ecstasy of St. Caecilia" 1516, Bologna. While the rudimentary violin still has flat surfaces, the key is the large and well-formed C-bouts pinching in the middle, attempting to fashion a clearly defined "head" and "chest" register. This was completely absent from centuries of predecessor stringed instruments, such as the rebec.

At the same time, Cosimo and his older son, Prince Ferdinando, had commissioned a set of instruments—two violins, two violas and a cello—from Antonio Stradivari, age 45. Ten months after the visit, Stradivari delivered to Prince Ferdinando his revolutionary violins, a breakthrough that is now designated as the first of the "Long Strads." After almost a quarter of a century of violin-making, in 1690 Stradivari altered his design to create a full, round, free and yet structured sound, one that amazed hearers.[2] Looking back, violins prior to 1690, those of the Amati family, of Maggini, of Stainer, would be remembered for their sweet sound or possibly their big sound, but it appeared paradoxical for powerful and sweet sound to co-exist in the same instrument. It was Stradivari who solved the puzzle of maximizing both freedom and structure, in a violin described by Joseph Joachim as having, uniquely, "a more unlimited capacity for expressing the most varied accents of feeling."[3] Stradivari had made a violin in the image of mankind. He would fully concur that he was, indeed, echoing the Creator.

The Violin Project Before 1690

After centuries of string instruments such as rebecs et al., a qualitative breakthrough occurs around 1500. There appear stringed instruments with well-defined c-bouts that sufficiently separate an upper chamber and a lower chamber—the violin. Tedious official histories of the violin will find safe ground in citing a contract for Andreas Amati to provide violins in the 1550s for a royal wedding; or even pushing the origin story earlier, by citing a painting from the late 1520s with something

1. See "The Secrets of the Florentine Dome" by Karel Vereycken, 2013: http://schillerinstitute.org/educ/pedagogy/2013/vereycken-dome-1.html *and* "Brunelleschi's Dome: The Apollo Project of the Golden Renaissance" By N. Hamerman/C. Rossi, *21st Century Science & Technology,* July-August 1989: https://21sci-tech.com/Articles_2014/Brunelleschi.pdf

2. *Antonio Stradivari: His Life and Work*, by W.H. Hill: "The year 1690 is perhaps one of the most interesting epochs in Stradivari's career; it certainly marks the most complete innovation as regards form, construction and proportions of the violin which took place in his work . . . We refer to the creation of the 'long Strad'."

3. Joachim was Johannes Brahms' favorite violinist. His quote in context is: "While the violins of Maggini are remarkable for volume of tone, and those of Amati for liquidity, none of the celebrated makers exhibited the union of sweetness and power in so pre-eminent a degree as Giuseppe Guarneri and Antonio Stradivari. If I am to express my own feeling I must pronounce for the latter as my chosen favourite. It is true that in brilliancy and clearness, and even in liquidity, Guarneri, in his best instruments, is not surpassed; but what appears to me peculiar to the tone of Stradivari is a more unlimited capacity for expressing the most varied accents of feeling. It seems to well forth like a spring… as if Stradivari had breathed a soul into them, in a manner achieved by no other master."*The Salabue Stradivari*, W.E. Hill, 1891, pp. 7-8.

looking like a violin. But the story is told with the underlying conceit that the violin must have started somewhere, but wherever it did start, it was rather accidental—sort of like an ape-man deciding one day to stand up straight. It is remarkable that Raphael's drawing of a violin in 1516 is simply ignored.

Once attention is drawn to Raphael's Florence of around 1500, it becomes rather unmistakable that the development of the violin was by design. Particular attention should be paid to the three years that Raphael and Leonardo da Vinci were both in Florence, 1504-06. Leonardo was no stranger to the design of instruments. The idea must have been based upon an attempt to unpack the workings of the amazingly full, powerful and beautiful sound of what we will designate as "bel canto" singing.[4] Beautiful evidence of such exists in Luca della Robbia's 1430s sculpture for the Cathedral of Florence, in which he captured the mouth positions of singers fully engaging their head register with their chest register. A character such as Leonardo would surely have been challenged to investigate the unique dynamics of such a laser-like event, even if it were happening inside a human being. It takes little to imagine a consequent interest in fashioning organic models, such as wooden models, of such dynamic couplings of two-chamber systems.

Luca della Robbia's Cantoria, sculpted for the organ loft of the Cathedral of Florence.

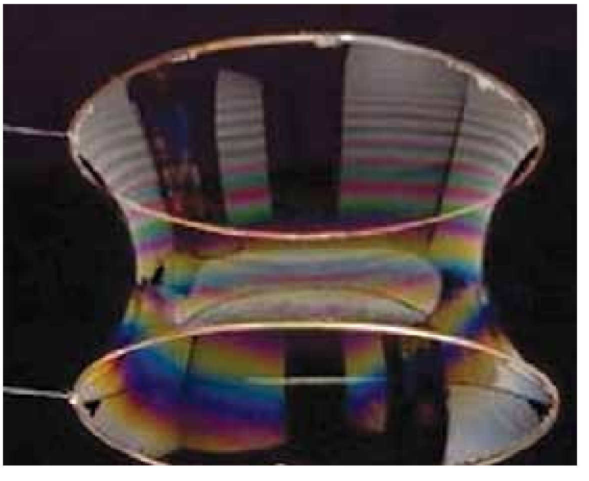
The first step in investigating this claim, however, is not to feverishly search for some "smoking pistol" proof, but rather to experiment by singing with the engagement of both head and chest registers; and then to fashion a mapping of your own discrete alterations that bring a qualitatively-new resonant coupling into play—one that neither chest nor head could produce individually. That there is a higher-order, dynamic interplay in multiply-connected—in this case, doubly-connected—spaces should, then, not be doubted. Admittedly, what one can succeed in unpacking about such a development may yet be a bit more challenging.

From no later than 1516 and continuing until 1690, there were fine developments in violin-making, centered around four generations of the Amati family of

4. See *A Manual on the Rudiments of Tuning and Registration,* Schiller Institute, 1992, on "bel canto" singing, with discussion on the "aperto, ma coperto" (open, yet covered) sound; the "voca impostata" (well-placed voice); and the properties of a round, full shape, while still clear—due to the lasing focus of the mask.

Least Action: The Soap Film

The soap film displays the least-action surface, a catenoid, connecting the two circles that serve as boundaries. As a first approximation, imagine a wire-frame boundary of two spaces, a "head" and a "chest" region, conjoined. Very modest alterations of the boundary conditions can result in dramatic changes in the soap film's delineation of least-action. (If you wish to begin training your mind to think about three-dimensional "least-action" surfaces, examine some of these soap bubbles: https://www.youtube.com/watch?v=YdneSMKObls from 08:50 to 11:00; and then go get some soap film, design some wire frames, and "go to town"!)



Cremona, Italy. Antonio Stradivari learned his craft from Nicolas Amati's workshop in the 1660s Cremona, either directly as a student, or indirectly from craftsmen trained and influenced by Amati. A good luthier (violin-maker) would literally hear the potentialities in the spruce and the maple by rapping the plate of wood, and making a mental map of the wooden plate's aural topography. One could form a map of the tonal qualities of the plate, not unlike the way a sculptor has to perform some sort of evaluation of the topography of the piece of marble he is to work with. Stradivari evidently developed a strong capacity for what might be called aural imagery.

However, the two wooden plates to be matched up for the front and back of the instrument were only the boundary conditions of the system.[5] Somehow, Stradivari, for his 1690 breakthrough, must have developed a sense for the unseen and unheard aerodynamics of the coupling of the head and chest registers.

Leibniz's Year Prior to Florence

Leibniz's scientific developments in the year prior to his 1689 visit to Florence provide our best insight into his discussions in Florence with Bodenhausen's group. In 1688, Leibniz was challenged to unpack and further develop the working of Johannes Kepler's solar system. While on a three-year trip (1687-1690), away from his home in Hanover, and to Austria and Italy, he examined a review of Newton's 1687 *Principia* in the Leipzig *Acta*. Leibniz recognized that the mathematical bowdlerization of Kepler's rich physical-science method of investigation was harmful, and he took up the challenge. He published his "Essay on the Causes of the Celestial Motions" in the *Acta Eruditorum*. In early 1689, he expanded that essay, using his differential and integral calculus to de-mystify, e.g., the causal workings of gravity. Leibniz viewed Newton's "action at a distance" formulation of gravity as having a medieval, occult quality—designed so as to inhibit scientific investigation.

Leibniz then had extensive dealings in Rome with members of the scientific institutions, where he found the axiomatic assumptions of René Descartes were also stultifying progress.[6] His "Phoranomus" dialogue, composed in July 1689, reflects his intervention there. He characterized Descartes' physics as dealing with dead matter, or "vis mortuam," and counterposed to it actual "vis viva," or living matter, for physical investigations.[7] Treating the physical world as inert stuff may make for a tidy package, but, as with Newton's mathematicization project, Descartes' approach was yet another version of reductionism. Rather, it was the scientific investigator's mind that had to rise up to the complexity of the subject of investigation and had to form whatever more advanced conceptual tools were necessary to account for the richness of nature.

For Leibniz, any motion worthy of investigation was one accomplishing work, and was one changing the world in which the motion itself was occurring. Leibniz's very title, "Phoranomus," itself is a term referring to the laws of what might be called substantial motion—as opposed to perhaps the more prevalent term, "kinematics," which would imply any sort of undifferentiated motion. The Greek word "phora" means to bear, as in to carry. Hence, space is not evacuated and void of directionality. Rather, some pathways through space work more efficiently than others. Leibniz would further develop this in his work on the catenary.

It is in this period that Leibniz expresses the need, as Bernhard Riemann would later put it, to investigate the hypotheses that lie at the basis of Euclid's geometry. It is not only a matter of removing false assumptions, but, even more, of figuring out why correct ones are correct. Beyond Euclid, Leibniz thought that the even more fruitful work of Greek physics and geometry, as reflected in the work of Archimedes, had to be put on a higher basis. In Leibniz's "Phoranomus" dialogue, his character Baldigiani describes the project:

> Hence you will conjoin a science most useful to life with great personal benefit, if you bring us such bright light in the great darkness we are in, and impose laws not only on statics, which Archimedes had formerly put under bondage, but

5. Simply within the level of the plate, a curious use of the "golden section" seems to set Stradivari apart from the Amati tradition. See "Stradivari's Golden Mean," http://wlym.com/archive/fusion/tcs/19890102-TCS.pdf, pp. 62-63.

6. Also in Rome, Leibniz met with Filippo Grimaldi, establishing an ongoing collaboration with him on cultural exchanges with China. (Later, after developing more of his transcendental curves, he would suggest to Grimaldi's missionary team that they should educate the Chinese emperor and his court on his "geometria situs" methods.)

7. When Leibniz got to Florence, he communicated with Francesco Redi, Cosimo III's head physician. Leibniz's conceptual drive for "vis viva" put him in Redi's camp vs. Buonanni. (Redi showed that Buonanni's "spontaneous generation" theory was wrong; that life could only be generated from other life.)

also on universal phoronomy and the explanation of moving forces.

Charinus, another character in "Phoranomus," explained:

In geometry and numbers, I observe evident principles of unavoidable necessity. Everything gets explained by parts of the same magnitude variously transposed. But the moving forces seem to me to possess something incorporeal I do not know of . . . Therefore, every time I would conceive the powers of machines, I was confronted with something unexplored and not admitting of any image.

Painting by Antonio Domenico Gabbiani. 1685.

Prince Ferdinando de'Medici at the keyboard with his musicians.

Hence, in his next work, *Dynamica*, Leibniz states:

I judged that it was worth the trouble to muster the force of my reasonings through demonstrations of the greatest evidence, so that . . . I might lay the foundations for the true elements of the new science of power and action, which one might call 'dynamics'.

Painting by Joseph Lecurieux.

Nicolo Amati (1596-1684)

Bartolomeo Cristofori (1655-1731)

Leibniz actually coined the word *dynamica* to address the power that was at play, though not visible. There were operative principles at work which were not visible, but were determinable—metaphysical, but not occult.

Leibniz in the Court of Florence

Florence's Duke Cosimo III de Medici employed Baron Bodenhausen to tutor his two sons, Grand Prince Ferdinando, then twenty-five, and his brother, Prince Gian Gastone, eighteen. Ferdinando was already quite passionate about music and was a patron of the arts. The year before, in 1688, Ferdinando had brought to Florence, Bartolomeo da Cristofori—the future inventor of the pianoforte. Cristofori was given a significant salary, with the assignment of restoring the ancient instruments in the collection of the Medici and of developing new instruments. (Cristofori was also to play in Ferdinando's chamber music group, the "Virtuosi da Camera.") Of some note, Cristofori had, evidently, lived with and trained under Nicolo Amati in Cremona, probably in the late 1670s—at the same time as, and in the same neighborhood where Stradivari made violins in his studio.[8] Certainly, Ferdinando had an expressed interest in developing new instruments; and it were

8 . The 1680 census in Cremona listed one "Christofaro Bartolomei" in the household of Nicolo Amati. Feathers get ruffled because he is listed as thirteen years old, whereas Cristofori was twenty-five. However, it would have been illegal for him to live there at that older age, so such an altered entry is not hard to understand.

likely that the man he especially sought out to hire, Cristofori, also was trained by Stradivari's teacher.

Perhaps more astonishing is that at the same time as the hiring of Cristofori, in 1688, Ferdinando moved Luca della Robbia's Cantoria sculptures of the "bel canto" singers crafted in 1438, into the Museum of the Florentine Cathedral.[9] On their 250th anniversary, the sculptures were taken down from the modest choir stalls in the church and, after a fashion, given new life. The issue of a lased, "bel canto" physical phenomenon was clear and present for Bodenhausen and Ferdinando, one year prior to Leibniz's visit and two years prior to Stradivari's breakthrough.

Leibniz arrived in Cosimo III's court some time in November, 1689. Then, no later than November 27, he paid a visit to Vincenzo Viviani, the pretended leading scientist of the court of Florence and a dyed-in-the-wool follower of Galileo. (As a youth, during Galileo's last three years, Viviani was his assistant. Later, he would be the first editor of Galileo's works.) Leibniz was cordial with Viviani. Afterwards, Leibniz reported that Viviani was "highly surprised" at his scientific methods, as Viviani "did not expect analysis to go so far" as Leibniz had developed it. Leibniz added: "It is true that it is only recently that it goes that far."

Aside from Bodenhausen, Leibniz's key collaborator in Florence was Antonio Magliabecchi, the head of Cosimo's library. While Magliabecchi didn't penetrate Leibniz's scientific work as deeply as Bodenhausen, he was a passionate man of letters, who had a remarkable relationship with the wealth of Renaissance culture. (He had a collection of 50,000 books and manuscripts. It was said that he had studied most or all of them, and that he could recite innumerable passages and quote the page of the book.) He had no trouble recognizing the breadth and power of Leibniz's mind, and he would play an ongoing role in radiating Leibniz's works throughout Italy.

Antonio Magliabecchi (1633-1714)

It was Bodenhausen who delved into Leibniz's method of scientific investigation. After several weeks together, Leibniz, rather remarkably, assigned Bodenhausen the task of editing for publication his manuscript, *Dynamica et potentia*, leaving the manuscript with Bodenhausen. Clearly, Leibniz was rather impressed with the level of comprehension and mastery displayed by Bodenhausen.

As part of his classes and discussions on *Dynamica* for Bodenhausen, and Ferdinando and Gian Gaston, Leibniz worked through some of his inventions for the two royal students. When one situates the intense four-to-six-week period of lectures and discussions, amongst the other two known factors—the fresh attention paid to the Cantoria sculptures and the unmistakable presence and influence of the remarkable architectural wonder, the cupola—the potential for all sorts of progress is apparent. As part of this, the type of "analysis situs" approach to the most efficient and powerful pathway—that is, the unique "least-action" pathway—for a coupled bi-chamber region, is quite credible and even rather likely.

The Fruits of Leibniz's Visit

After Leibniz left Florence on December 22, 1689, Bodenhausen's group pursued Leibniz's *Dynamica* on their own. Bodenhausen reported to Leibniz on the ongoing scientific discussions.[10] It was during this period, the spring and summer of 1690, that Stradivari crafted his new "bel canto" instruments that were delivered to Ferdinando in early September, 1690. For his part, Leibniz solved the scientific puzzle of the catenary no later than July, 1690, seven months after his visit to the cupola.

First, however, Leibniz had to complete his assigned genealogical research for the House of Hanover, amongst the d'Este family's records in Modena, Italy.

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9. The sculptures had spent 250 years adorning a small choir stall in the Cathedral. Now, they were given a prominent place in the Museo dell' Opera del Duomo, next to the Cathedral.

10. From 12/31/1689 to 8/12/1690, a period covering Stradivari's work, there are twenty exchanges between Bodenhausen and Leibniz. (The two exchange a total of seventy-six letters before Bodenhausen's death in 1697.) Also, during the eight months in question, there are seventeen more letters between Leibniz and Magliabecchi.

Leibniz arrived there on December 28, 1689 and spent five weeks there. Of some interest, his host, the Duke of Modena, Francesco II d'Este, played upon a Stradivarius cello, which Stradivari had personally delivered to the Duke in Modena less than four years earlier.[11] This might have been the first occasion that Leibniz heard an instrument by Stradivari, though there is no record of his interchanges with the Duke.

Antonio Stradivari (1644-1737)

One distinct possibility for Stradivari hearing of Leibniz's insights would have been through Francesco II. By this scenario, Leibniz would have heard, in Francesco's cello, a wonderful instrument, but yet one not quite up to its potential. Francesco personally knew Stradivari and could have easily communicated to him. The only "stretch" here would be—barring an actual direct meeting of Leibniz and Stradivari—whether Francesco would have understood Leibniz's thinking well enough to communicate something truly insightful for Stradivari. The direct link between Florence's Bodenhausen/Ferdinando team and Stradivari still remains the more likely avenue.

Leibniz, having completed his research for his Hanover rulers on their potential link with the d'Este family, left Modena on February 2, 1690. His trip home to Hanover, Germany included stops in Venice, Italy and Vienna, Austria. He arrived home in the latter part of June. His report that he had solved the catenary puzzle appeared in the July, 1690 *Acta*.

Meanwhile, back in Cremona, Stradivari worked on his new instruments. Stradivari had actually received the commission for the Medici instruments in 1684;[12] however, while he completed other commissions within months, he appears to have only crafted his first three new "long Strads" six years later, in the spring and summer of 1690. Once he made his breakthrough, he worked rapidly. In October, 1690, he worked on the two violas, completing the set of five instruments.[13] It is not known why Stradivari delayed work on the Medici commission, but given Ferdinando's expressed interest and commitment to new instruments, Stradivari might well have been experimenting for five years without achieving a satisfactory breakthrough. Regardless, it suggests that, after more than five years of delay, Stradivari's bold new conception was realized in the first few months of 1690. There is no record of what discussions and/or deliberations occurred between the Bodenhausen/Ferdinando group in Florence and Stradivari in Cremona during that time.

On September 19, 1690, Stradivari received a letter from the Marquis Ariberti of Cremona, who, in 1684, had ordered the instruments for Cosimo III, reporting: that he had delivered the two violins and one cello to Prince Ferdinand; that the court was quite struck by the sound of them; and that the alto and tenor violas were eagerly awaited. "All the virtuosi gathered in his court are of the same sentiment that they are perfect … In earnest, I must beg you to commence at once with two violas, that is to say the tenor and contralto, which are lacking, to make complete the entire concerto"—that

11. Francesco's sister, Mary Beatrice, had just been deposed, a year earlier, as Queen of England, in what was titled "The Glorious Revolution." She was the wife of James II. (The set of instruments ordered from Stradivari, for James II in 1682, have never been located.)

12. In 1775, Paolo Stradivari sold his father's tools and relics to Count Cozio di Salabue. Later, Cozio's grand-nephew, the Marquis Dalla Valle, came to possess a 1684 letter by Stradivari as to the order for the instruments for the Grand Duke of Florence, Cosimo III, the order placed by the Marquis Ariberti.

13. The moulds and paper templates still exist for the instruments. Stradivari's handwriting, inscribed on the walnut mould, records the "forma nuovo" used for the "Gran Principe di Firenze"—dated October 4, 1690 for the Contralto Viola and October 20, 1690 for the Tenore Viola. He had been urged to finish these last two on September 19, 1690.

is, to complete the entire concert of five instruments.

Bernoulli's Catenary Contest

In the May, 1690 issue of *Acta*, Jacob Bernoulli posed the challenge of figuring out the catenary, or "hanging rope," curve—that is, to derive and define the curve assumed by a rope, or a chain, that is suspended at both ends. The catenary distributes the effort, of supporting the links of the chain, equally throughout the curve. As the most stress-free pathway, it was found to be invaluable in Brunelleschi's solution to the puzzle of erecting a dome to span such an unprecedentedly large opening.[14]

Jacob Bernoulli (1645-1705)

While Bernoulli was well aware of Leibniz's works and methods, it is not clear whether Bernoulli's choice of a catenary contest had any link to awareness on his part that Leibniz had just visited the cupola in Florence. Their correspondence seems to begin in earnest only after Bernoulli's May, 1690 challenge on the catenary. Prior to that, Bernoulli's relationship with Leibniz was confined to his close following for several years of Leibniz's works in the *Acta*. Otherwise, in the period before the May, 1690 challenge, Jacob Bernoulli's dialogue partner on the catenary was his younger brother, Johann, whom he introduced to Leibniz's methods.

Bernoulli had immersed himself in Leibniz's analytical methods, beginning with the historic, 1684 "New Methods." In the May, 1690 *Acta*, Bernoulli was actually responding to a challenge posed by Leibniz in September, 1687, called the isochrone, or equal time, curve: "To find the curve of descent along which a heavy body descends uniformly and approaches the horizontal by equal amounts in equal time intervals."[15]

Huyghens had immediately sent in an answer, which was published in the next issue of the *Acta* along with a more extensive treatment of isochrone by Leibniz. It was Bernoulli's study of that material that prompted his May, 1690 article, at the end of which, Bernoulli posed his catenary challenge. Bernoulli had worked through Leibniz's new methods, including his calculus, and had followed Leibniz's attempts to educate Huyghens on Leibniz's more powerful generalized methods, which had been based upon Huyghens' prior work, and now he wanted to join the dialogue as an active participant. Bernoulli's fortunate and particular choice of the "hanging-rope" problem may have been the one truly timely coincidence of Leibniz's 1688-90 period.

For many years, both Leibniz and Huyghens had been well aware of the catenary problem. In Huyghens' case, some forty years earlier, he had proved that Galileo's solution—that the falling-rope curve was the parabola—was not, and could not, be correct. Neither Huyghens nor Leibniz had gone any further in solving the problem until 1690. Immediately after arriving home in June, 1690, Leibniz composed and submitted his article on the catenary, published in the July, 1690 *Acta*:

> This problem, proposed by Galileo and famous since his time, has not yet yielded to solution . . . I have attacked [it], which I had hitherto not attempted; and with my [analysis situs] key, happily opened its secret approaches. However, this problem is a little more involved than my former one [on the isochrone] and displays a certain singular use of our method; thus I have thought it worthwhile, before publishing my solution, to give time also to others for exercising their skill. By this, as by the Lydian stone,[16] we shall know

14. For a treatment of the catenary and its link to the cupola, see Bruce Director's "The Long Life of the Catenary: From Brunelleschi to LaRouche," *Fidelio,* Spring 2003.

15. Contrary to some commentators' confusion, this is not the same as Huyghens "tautochrone," or same-time, curve. Leibniz was posing, what were the boundary conditions (here, the beginning and end points), or what was the shape, of a curve whose constraint is that, while the body falls under its own weight, it falls equal amounts in height, in equal amounts of time. (Obviously, the lateral distances traversed, and the areas subtended, do increase.)

16. In ancient Lydia, a pure silver or pure gold coin would leave a standard mark on a special black stone. The "touchstone" test of suspected coins would leave different marks if they weren't up to standard.

the best methods; which bears much on the improvement of the science.

His first letter to Jacob Bernoulli (Sept. 24, 1690) modestly assured him: "I think I can satisfy you regarding the catenary curve as well." Leibniz's powerful discovery would introduce scientists to the amazing corollary, that all the powers and properties of logarithms were derived from, and subsumed under, the catenary—that the catenary was a sort of physical algorithm, that underlay the human-engineered, cultural device called a logarithm.[17] The contest ran for one year before the June, 1691 *Acta* published Leibniz's historic work, along with the submissions of Huyghens and the two Bernoulli's.[18]

Domenico Tempesti

Vincenzo Viviani (1622-1703)

After the birth of the "bel canto" Stradivari violin and of the catenary curve, Leibniz made a forecast regarding the higher-level methods that he had introduced, leading to the development of the transcendental curves, e.g., the catenary, the logarithmic spiral, the cycloid and the tractrix. On December 27, 1691, he wrote to Johann Bernoulli's student and patron, Guillaume de l'Hôpital, about what was variously called "analysis situs," "geometria situs" and "characteristic situs"—that "unless made believable through examples of some importance, it would be regarded as just a vision. Nonetheless, I see in advance that it will not fail." Leibniz had his reasons for such confidence.

The Beautiful Dome vs Euclid's Ass

Earlier, in October, 1690, Leibniz had written Bodenhausen of his success with the catenary, and Bodenhausen informed Leibniz (Jan. 19, 1691) that their collaborator, Magliabecchi, would communicate Leibniz's results to two stubborn defenders of Galileo, who had resisted Leibniz's scientific advances:

> Mr. Magliab promised me to advise Gulielmini in Bologna and Marchetti in Pisa, who will not be able, alongside the loud-mouthed of this town [Viviani, of Florence], to smash this chain [the catenary!]—especially the second one, who shouts everywhere that analysis and algebra are only fatigue-work for the ultramontanes [meaning, for the Germans, Leibniz and Bodenhausen] who lack genius . . .

Bodenhausen personally provided Viviani with Leibniz's catenary solution; however, Viviani simply refused to look at it. His hero, Galileo, had been proven wrong, and Viviani was apparently too sensitive to learn any better. Rather, he chose to lunge flight-forward at Leibniz.

Viviani had been embarrassed at the court of his patron, Cosimo II, both by Leibniz's work with Bodenhausen and the princes, and, again, by Leibniz's catenary solution. He represented to Cosimo that he could turn the tables on Leibniz. On April 4, 1692, Viviani sent to Leibniz a "curious" problem he had devised. In sending it, Viviani used a code name (an anagram of "postremo Galilei discipulo," or Galileo's last disciple) and Cosimo instructed his ambassador in Vienna to forward the "Geometrical Enigma" to Leibniz in Hanover. It was much ado about very little.

Leibniz solved it the day that he received it, and included a letter that explained how his analytical methods and calculus made such problems easy to solve. However, Leibniz was being polite. Viviani had actually constructed a problem that involved finding the surface area of a hemisphere with four rectangular windows cut out, as if it were the top of some building. Compared with the fascinating problems of the shape and construction of the Cupola of the Cathedral, Viviani's foray into this contest with Leibniz was pathetic.

17. See Pierre Beaudry's translation of Leibniz's "Two Papers on the Catenary Curve and Logarithmic Curve": https://www.schillerinstitute.org/fid_97-01/011_catenary.html and Bill Ferguson's translation of Johann Bernoulli's work on the catenary curve: http://21sci-tech.com/Articles%202005/Bernoulli.pdf. Also, an account of Ferguson's class on the catenary: "Experimental Metaphysics: Leibniz's Infinitesimal Captive," by Michael Kirsch and Aaron Yule. https://science.larouchepac.com/publications/dynamis/issues/october06.pdf

18. Given Newton's bizarre submission to the later, 1696 Brachistochrone Contest, one can be thankful that he didn't simply suspend a rope, trace out the curve on a piece of paper, and send it in. In 1690/1, Newton, rather prudently, kept silent.

He could not have picked an example that would put him in any worse light. Leibniz explained to Ferdinando that Viviani's non-proof was a "simple mode of exhibiting a figure obtained by the intersection of a sphere and a cylinder." This matter of Archimedean statics had already been conquered and superseded in Leibniz's discussions in Florence with Ferdinand—but Viviani was clueless.

Magliabecchi wrote to Leibniz about Viviani's intrigues in court over his challenge to Leibniz:

> They have concealed the problem, not only from Sig. Baron B[odenhausen] and me, but from all our friends . . . Surely he had it sent to you, illustrious Sir, because he thought that you . . . were unable to solve it, and he could then fill the court with the scandal that you are ignorant; and the Sig. Baron and me, ignorant and malignant, for celebrating you so much. That is why he used all means in order to hide it.

Further, Bodenhausen related Magliabecchi's description of Viviani's faction: "They always do all their things through cabal, and with a villainous politics; nobody could possibly be more malignant than this geometer [Viviani]: an ass who does not know anything besides Euclid."

There is a deep irony in the way that Viviani attempted to strike out against Leibniz. Leibniz became the first man in history to master the catenary curve, the curve at the heart of the secret of the construction of the Cupola in Florence, and a breakthrough in the new science of transcendental curves. Viviani, the leading professor of Florence, imagined that a hemisphere with round windows cut out—that is, with cylinders cutting orthogonally through the hemisphere—could somehow give Leibniz pause for thought. Nothing of the beautiful, inspiring challenge of the crowning of the Cathedral in Viviani's own backyard seems to have ever touched his heart or creased his brow.

Stretto: LaRouche's Echo of Leibniz

Lyndon LaRouche had a comparable experience to that of Leibniz's 1689 visit, in his own encounter with the Cathedral in visiting Florence in 1988. It became a central metaphor for LaRouche in delineating the relationship between truth and beauty:

> 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.[19]

LaRouche continued, that in Brunelleschi's solution of the doming of the Cathedral,

> . . . 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.

With this, we come to our quadruply-connected conclusion. First, LaRouche's argument for "the mind of the sculptor" feeling "the impact of what Leibniz defined as a universal physical principle of least action" might equally well be made for, second, the mind of Stradivari in divining the least-action pathways of the conjoined upper and lower chambers of the violin.

19. "Believing Is Not Necessarily Knowing" by Lyndon LaRouche in 1/17/2013 EIR. http://www.larouchepub.com/lar/2003/3002believe _ know.html

Third, the mind of Leibniz, the master of "analysis situs," might discern the role of the catenary in mentally recreating the construction of the Dome.[20]

And, finally, LaRouche's argument for a Leibnizian "vis viva" approach to sculpture and architecture was crafted, independent of any knowledge on his part of Leibniz's actual experience with the cupola three centuries earlier. So, the fourth level, the mind of LaRouche, a master of the "analysis situs" as to how ideas causally transform the physical world, could identify the role of Leibniz himself participating in that process, in mentally reconstructing the relationship of truth and beauty.

20. This author had the opportunity to pose to LaRouche the role of Leibniz's visit to Florence as an inspiration for his subsequent solution of the catenary. As I recall, he was a bit surprised that Leibniz had actually been there. I imagine that the thought triggered memories of the fruitful effect that the cupola had upon him. Then he quickly and happily concluded, "Why, of course!"

The 1690 'Tuscan' Stradivari Violin


santacecilia.it

The 1690 Tuscan Stradivarius Violin.

Stradivari's "long Strad" model introduced the "bel canto" violin and was his key design over the next decade. But he continued perfecting his violin for three more decades. There are many recordings with his "bel canto" violins, but very few with the first one.

Gioconda De Vito performed on the 1690 "Tuscan" Stradivari violin, on loan from the Italian government beginning in 1953. Here she performs the famous Bach "Chaconne" in 1957 . While there are limitations to the recording—and, further, the full, surrounding sound of a Strad must be experienced live—still, some comparison can be made with her 1952 performance on a fine 1762 Gagliano violin. Same player, different instrument:https://www.youtube.com/watch?v=ZBQBF3c_T6w. In this 1952 performance, De Vito is soloist in the Brahms Violin Concerto, conducted by her close collaborator, Wilhelm Furtwängler. (Again, there are significant recording limitations, but one can still enjoy the poetic collaboration.)

Of some note, in 1953, De Vito actually performed a Brahms sonata on the "Tuscan" Strad, with Furtwängler himself accompanying her at the piano. They played for Pope Pius XII, at Castel Gandolfo, the Summer retreat of the Pope. Pius had specifically requested the particular Brahms sonata. Furtwängler was impressed with the Pope's knowledge of the classical composers, and learned that playing the violin had played a key role in the Pope's life.

Finally, the Pope wanted to hear De Vito perform Mendelssohn's Violin Concerto, which she did on the Strad in 1957—but Furtwängler was no longer alive. Earlier, in Italy in 1952, Furtwängler had conducted the Mendelssohn with De Vito as soloist, playing her Gagliano. (Indeed, it is likely that the Pope had heard of this performance, had heard this particular recording, and, as a consequence, had requested the Mendelssohn.)

Rome's Accademia of Santa Cecilia produced this video on the "Tuscan" Strad. Fabio Biondi performs part of Biber's "Passacaglia" on it. Acoustics are a bit echo-y, but there is no mistaking the unique sound of this violin—the simultaneous combination of beauty, strength and expressiveness.

View at: https://www.youtube.com/watch?v=dd__GgqiYLo&index=2&list=OLAK5uy_lKWwblKV_rucQGsJtxWz790MIK6kqR0_o&t=0s

With this level of contrapuntal developments, it is time to turn to John Keats, who addressed the matter in his “Ode on a Grecian Urn”:

Heard melodies are sweet, but those unheard
Are sweeter; therefore, ye soft pipes, play on,
Not to the sensual ear, but, more endear’d,
Pipe to the spirit ditties of no tone . . .

Epilogue: the Real ‘Glorious Revolution’ of 1688/9

Gottfried Leibniz actually did owe a modest debt to Isaac Newton, though it had nothing to do with calculus. Newton’s project to turn Johannes Kepler’s work on the solar system upside-down, to formalize it in mathematical equations, was actually part and parcel of the takeover of England and its transmogrification into an Empire—called by the victors, the “Glorious Revolution” of 1688/9. But Newton’s project also usefully impelled Leibniz in 1688 to come to Kepler’s defense and to develop physical science with his new and powerful “analysis situs” methods.

Leibniz’s method was based upon a lawful relationship between the Creator and what was created, the creations. While Euclid and Newton had their underlying axioms, Leibniz’s method assuredly contained an underlying hypothesis, stemming from Plato, who announced in his *Timaeus* dialogue that God is good. That means, amongst other things, that the Creator has a lawful relationship with mankind. In a lawfully created world, one made by a good Creator, there is neither any part, nor any way to figure out a part, except as part of a whole. Any investigation has to account for fundamentals, from the top down. Humans can and should conform their actions, so as to be in the image of the way the Creator acted—the universe, galaxies, solar systems, life and humans were created.

For Plato, Kepler and Leibniz, this proper investigation of the world is the way we truly discover who we are; and it brings us closer to our Maker. For all three, there is a fundamental coherence between the harmony of the solar system and the harmonic tuning of humanity’s ear. This coherence may be somewhat of a miracle; but it is also practically the definition of “beautiful.” The fountainhead of beauty is a world where a good God created mankind in his image. As such, Keats concluded his above-cited “Ode”: “Beauty is truth, truth beauty—that is all / Ye know on earth, and all ye need to know.” Humanity really does have an inner compass in the difficult pursuit of truth, and that is its passion for beauty.

EIRNS/Kathy Wolfe

Norbert Brainin (left) and Gary Strum examine 1709 Freffuhle *Stradivarius from Cremona.*

Leibniz’s passionate search for truth, in his 1688-9 development of Kepler’s physics, happily intersected his trip to Florence and its beautiful domed Cathedral. It is hard to deny that two glorious breakthroughs were, indeed, the fruit of those weeks in Florence—the lawful development of the family of transcendental curves, and the revolutionary “bel canto” Stradivari violin, with its union of power and beauty. Here we have the conjoined case where:

(a) the beauty of the Dome impels a truthful scientific breakthrough, and
(b) the truth-seeking of Leibniz’s new physics spreads the growth of beauty.

This does qualify as the actual “Glorious Revolution” of 1688-9—and one that may serve as a model for humanity today, not only in performing our duty to develop Africa, the globe and the solar system, but to restore to our beleaguered culture an honest and open relationship with beauty.