Amazing Labyrinths

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Abstract

Unicursal labyrinths have increasingly gained interest recently, especially among spiritual and esoteric communities all over the world. (Multicursal mazes, also very popular lately, are not discussed here). This paper describes several geometrical and playful aspects, starting from the 800-year-*young* Chartres labyrinth, which itself is then found stemming from the 5000-year-old "Classical" labyrinth. The unusual Chartres design has been copied in many places and has spawned a number of simpler layouts that echo the original. I present a seven-circuit Chartres look-alike that emerged from a study I conducted four years ago in which most of the features of the original Chartres labytinth have been preserved, thanks to the method I used for its generation. Note that even though I since discovered a variation of this design was built twenty years ago as a maze and that my analysis/generation method was used already, albeit in a different way, I was fortunate I pursued my initial research without knowing this. Some of my work has been devoted to the negative maze content of the Chartres labyrinth, i.e. when the boundary is "walked" instead of the path, it reveals three entry points and three corresponding ultimate goals. A very convincing pseudo-maze can be obtained using an Escher-like visual trick to conceal the topological impossibility of progressively changing some boundaries into paths. I took a further leap to infinity based on a fractal approach, by modeling true 3-D labyrinths on the computer, departing from the so-called 3-D labyrinths that are mere 2-D mappings on shallow surfaces like hilltops. I briefly conducted the latter study for the "Classical" labyrinth, and used KnotPlot advantageously; a few renderings are shown. Finally, I mold this new information into a possible simplified chronologic history of the Chartres design and present more than a dozen novel labyrinths that were mowed in prairies. Three have become permanent.

1. The Chartres labyrinth and its features

The first, striking impression that the circular Chartres design radiates out to the fascinated mind is a perfect and peaceful order. One immediately wonders how it works, how all eleven concentric, apparently symmetric paths (**feature 1**, see all features numbered on fig.1) eventually lead the *pilgrim* meandering to the middle, and furthermore, in doing so, having these meanders even forming a cross shape with facing bends or folds or turnabouts on three among the four branches of the cross, **feature 2**. It is a pilgrimage in its very essence even if the person enjoying it is foreign to the Catholic faith. In fact, only the six central lobes, **feature 3**, and the "lunations" on the periphery, **feature 4**, and the path/wall thickness ratio of about a bit more than 4-to-1, **feature 5**, make the distinct "Chartres" design (in much the same way the identical topology of the labyrinth in the Amiens cathedral is distinguished by a one-to-one ratio, the inverted path(black)/wall(white) coloring and its octagonal insead of circular shape). Yet other labyrinths in several countries share this topology, like the wall engraving in the entrance of the Lucca cathedral, close to Pisa in Italy, the UK Breamore labyrinth. And even the St-Omer labyrinth in Northern France, where the identical pattern is almost unrecognizable. So one is compelled to try to understand the working of that long peregrination towards the center, which during the centuries has received its share of mystical interpretations. I am not examining those interpretations in this paper, even though a number of them could have been instrumental in the very way, labyrinthine itself, the peculiar windings were brought into existence. I am only going to observe the geometrical features, and later introduce ludical aspects. I am an engineer by training, and I was puzzled by this intriguing marvel. To gain insight into

the "mechanics" of this design, I went to the only radial zone, or branch of the cross, that looks different, which I call the "entry and end/goal/target/arrival layout" (**feature 6**). Then I "cut" between the two radial contiguous paths at the mound of the labyrinth, deploy it, and unfold it like an annular steel or rubber bar into a large rectangle with the path progressing on 11 parallel lines. You can shrink this rectangle into a square pattern that now makes the characteristics of the topology easy to understand (Fig. 1, where the shrunken square pattern only displays the path or the Adriadne thread of the old Greek myth). The first remarkable fact that emerges from this figure is its central symmetry, when rotating it about the center point 180 degrees, or reflecting all points through the center you indeed obtain exactly the same shape (**feature 7**). The most striking feature is the *diagonality* of the progression, along a real "pilgrim step", **feature 8** ! (This also shows the origin of the cross shape itself, which divides the square in four series of 11 "registers".) Two register stretches forward, one backward, two forward again, etc… like in the Echternach procession. The main diagonal pilgrim step, the largest, is diagonally sided by smaller ones, **feature 9**, and the end arrangements take care of the connectivity, **feature 10**. This is why you keep wandering through all sectors in this labyrinth, getting close to the center then drifting away again. One further recognizes the lateral *invaginations,* one register stretch long, of the radial entry and final lines, one to the left, the other to the right with an offset of one, **feature 11**. These collect folds into four buckets, **feature 12**, with two contiguous folds each, **feature 13**. On the three other radii, folds are placed in opposition and form the overall cross shape between continuing paths, **feature 14**. On the central and exterior edges, the initial perfect symmetry impression is broken at the crossings with 0, 1 and 2 numbers of continuous edge paths, **features 15 & 16**. All these features, and an important additional **feature 17** made clear hereafter, make the Chartres design unique among all other 11-circuit medieval designs in my opinion. (On this point I differ from the otherwise remarkable work of Jacques Hebert [1] which I later discovered.)
There are several ways to generalize the design. The first is to develop labyrinths by changing feature 2, replacing the cross of four radial branches by either 1, 2, 3, 5, 6, 7 or 8 radii (which I will not describe here.)

2. Generation of a "mini-Chartres labyrinth" with a maximum of genuine features

By studying the recent successes of labyrinths and the creation of new ones using the Internet, I decided to use the analysis method of above as a design tool to develop a mini-Chartres layout retaining many of the features of the real Chartres labyrinth. So I came up with a 7-circuit design with ALL BUT TWO features above. Only feature 1 (due to the 7 circuits here) and feature 13 (as the buckets here contain only one fold) are different. The nicest feature is this pilgrim's step together with the typical "entry and end layout", feature 6. (fig. 1)

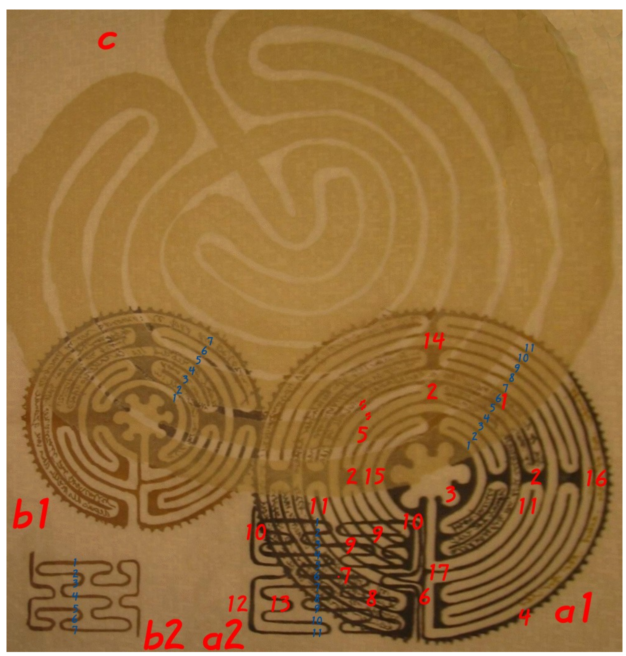

Figure 1: Lithographic stone with Chartres labyrinth and its small brother, with texts reverse)hand written along the longest stretches of pilgrim's steps. Other stone with "Classic" labyrinth for the back-ground..

3. Chartres labyrinths extended *fractally* to infinity

The previous model may be wrapped into a cylinder, to form what I call a "Chartres bracelet" (Fig. 2). That can be morphed into a "Chartres mug", here chained as a superposition of both the real labyrinth and my mini version (Fig. 3). By then assembling the cylinders and looking inside, you discover the Chartres design extending to infinity (Fig. 4) (To do this, I used the powerful KnotPlot program somewhat "right-brainishly" [2] !

Figure 2: *Chartres Bracelet*

Figure 3: *Chartres Mug*

Figure 4: *Chartres fractal to infinity*

4. A mazing Chartres

When you walk the Chartres labyrinth on the "walls", you actually wander in a maze, with typical maze branches and dead-ends, a "multicursal" folded tree graph instead of an outside-to-center "unicursal" folded line... There actually are three entrances then, each one leading, after a number of branches, to a distinct more or less distant "goal" (see the rough sketch in fig. 5.) These three paths eventually fill the whole layout, one of them even coming adjacent to itself on a part of its way. A more visually appealing layout, a *pseudo-maze,* emerges if one plays a nice interior-exterior game. Using an Escher-like visual trick with grey zones, you can fool your senses with and "overcome" topological impossibilities. The rough sketches in figs. 6 and 7 show this. Notice, by the way, how the path to the goal brings you in fact to the edge, again the same way in both designs, confirming how closely they are related.

Figure 5: *Chartres maze(s)*

Figure 6: *Chartres pseudo-maze*

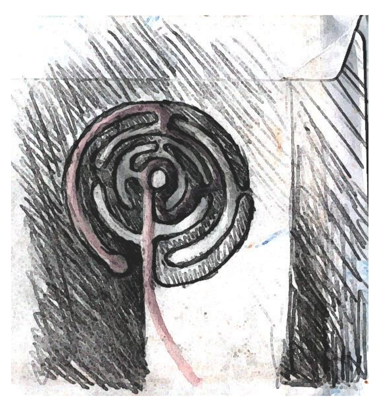

Figure 7: *Mini-Chartres pseudo-maze*

5. Relationship between the Classical and the Chartres Labyrinths

Reading much more on labyrinths, including the important work of Kern [3] have brought me to the "Classical" labyrinth, just to discover that my mini-Chartres -of which I was so proud- is in fact a circular "Classical" with turnabouts on the axes, and the "mini" appears to be halfway *between* the Chartres and the "Classical". This gave me another perspective on the genesis of the Chartres, perhaps the most accomplished of all medieval labyrinths.

Further digging in Internet revealed that the topology of the "Mini-Chartres" has also been developed as a maze by Randall Coate and Adrian Fisher, of Minotaur Designs in the UK, and built in 1981 in the gardens of Greys Court (near Henley-on-Thames, Oxfordshire, England [4]) as "The Archbishop's Maze" (see combined designs in fig. 8.) Indeed, the stone paths are connected here, which gives the maze characteristics of branching possibilities.

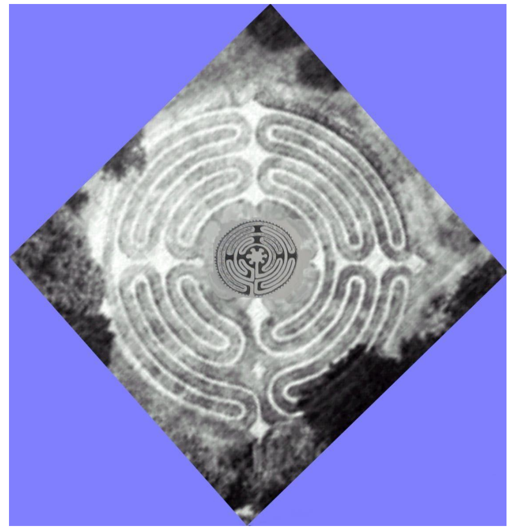

Figure 8: *Upper Views*

http://www.mazemaker.com/Projects_GreysCourt.htm

Evidently around the beginning of the present era, after two or three thousand years of existence of the "Classical", some people realized that this "Classical" (with its typical brain-shape, constructed from a "seed" in the form of a cross with equal sides, actually the "+" plus sign, four dots in the corners, and four quarter circles in between (fig. 9a)), could undergo some useful changes (fig. 9b):

- first, the shape could easily be *circularized*, by offsetting, **feature 17**, the lateral sides of the seed cross to compensate for the mismatch under there, the dots and the quarter circles moving along;
- second, the sort of "fingers" at the upper dots, instead of *looking* downwards to the others, were brought like those other two to *look* towards themselves, with the little offset;
- and third, capitalizing on the circular form, enlarged the center (the *goal* or *target* of the "classic"), into a comfortable central circular area.

These three changes produced a more symmetrical appearance, while preserving the topology of the labyrinth (fig. 9c).

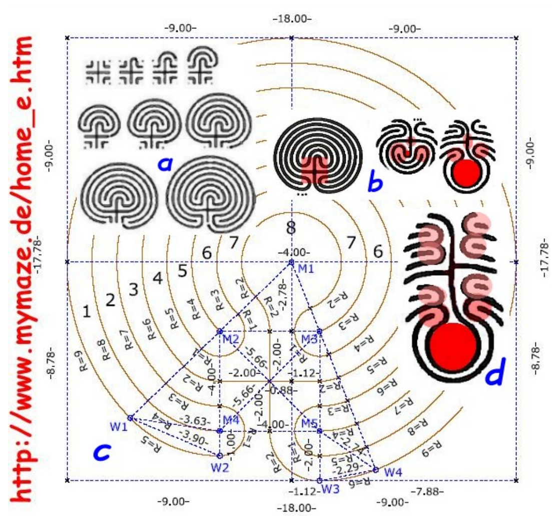

Fig. 9 *"circularized classical"*

Around 860, [3], (or perhaps earlier) during the early Christian Middle Ages, a scholar Heiric of Auxerre [3] realized that the *circularized* "classical" labyrinth no longer displayed a cross. So, (perhaps inspired perhaps by the square or circular mosaic Roman labyrinths presenting four distinct quarters and thus an axial cross) he realized the cross could be reintroduced using meander turnabouts in the following way:

- first, starting from the horizontal sides of the disfigured cross, one follows the circle up to the horizontal axis on both sides and places there facing turnabouts, sometimes called *labrys*;
- then, deciding in a clever and beautiful move (feature 14), to keep the adjacent circles continuing their way, and placing as many turnabouts as possible, i.e. two at each side of the horizontal axis, leaving single and double turns at the periphery and at the center;
- finally, on the vertical axis, instead of starting from the center with one or two circles, just starting with a turnabout, which ends up with an outer turnabout as well.

These changes bring us exactly to my mini-Chartres, which I found the other way around !
One last change, of great topological significance, because it suddenly rendered the design *spawnable* to larger labyrinths like Saffron Walden in the UK as well as my infinite labyrinth (above, fig. 4), was to double the "fingers" within all four of bracket-like envelopes. The seed now looks as in Fig.9d, the generating figure of the very Chartres topology. Only some 350 years later was the actual Chartres built, with its distinct peripheral "lunations" and the inner six-lobes, metaphors of the lobes of the large stained glass window on the facade of the cathedral.

6. 3-D Chartres and "Classical" labyrinths

We can now explore the Chartres and the "Classic" labyrinths as three-dimensional structures. Several different solutions exist for the latter, depending on how the central cross is treated (figs. 11 and 10, respectively). Fig. 12 shows the two looking from above, revealing the familiar sights using the KnotPlot orthogonal projection to avoid spoiling depth effects. Fig.11a shows part of a project for the city of Chartres. Another 3-D possibility was to turn the circuits into a "sphere" (fig. 11b).
I recently discovered that the idea of cutting the layout and distorting it has been used by Jo Edkins [5], (however, without "shrinking" the resulting rectangle, a step that lead me to discover the diagonal "pilgrims steps", that I believe are the most striking aspect of the Chartres design.) Edkins also points out that the Lucca labyrinth is not necessarily older than the Chartres one.

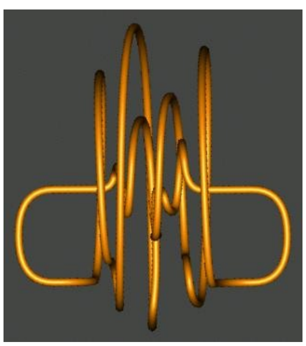

Figure 10: *3-D «Classic»*

Figure 11: *3-D Chartres*

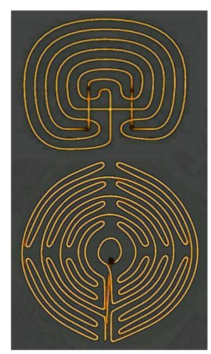

Figure 12: *Upper Views*

7. New works based on the "Classic" and Chartres designs

My explorations of this "Classic" to Chartres transition have led me to a number of labyrinth works, namely variations on the hexagonal 3-circuit "micro-Chartres" stemming from the wheel of colors (fig. 14-10). These are briefly presented here in the form of the affiches developed to bring them in the public. Most are "land art" -ephemeral installations made with a lawn mower in public parks, domains and prairies- however three have become permanent in Belgium. Some are projects of monumental sculptures. Motivations, design details and landscape pictures will be provided during the presentation.

Figure 13: *Labyrinths mowed in Belgium : 1a-d, six in "Les Jardins d'Aywiers"; 2a-c, three permanent: Ardelle Square, Rosières; Parentville, Couillet; and Sobieski Park, Brussels.*

Figure 14: *More labyrinths : 1-5, mowed in Regional Park, Hélécine, for the Rotary Club of Jodoigne; La Pommerage, Genval, for Philippe Jacquet; Park of Wespelaar, during a fund raiser for the Children Hospital Queen Fabiola; Park Tournay-Solvay, Brussels; Cultural Center Den Blank, Overijse; 6, project for Solvay Domain, La Hulpe; 7, Affiche of personal exhibition in Den Blank, Overijse; 8, monumental project in corten steel and stone for Villard-de-Lans, France; 9, Zome model of Fig. 13-1c [6]; 10, wheel of colors on micro-Chartres. Grateful thanks are due to the individuals and organizations who kindly accepted or invited those ephemeral and permanent installations.*

It can be seen on the trompe-l'oeil of fig.14-7 that the play on path and wall leads to funny results, namely another three-dimensionality with bridges and tunnels, which has been proposed in steel on fig. 8.

Acknowledgments

In addition to those expressed in caption of fig. 14, specials thanks are certainly due to **Mrs. Patricia Limauge** of "Les Jardins d'Aywiers" who kindly opened this domain to the six labyrinths of fig. 13 a-f; to **Professor Francis Buekenhout** of the University of Brussels who supports this work and suggested a labyrinth should be installed on the Parentville Campus; to **Mr. Serge Kempeneers** and his team of the **IBGE**, the Brussels Park Authority, for the labyrinth in Sobieski Park; to **Mr. Jacques Vandenbroucke**, director of the Solvay domain in La Hulpe, who supports my work from the beginning, and to **Mr. André Delmarcelle** and the Administration of the **City of Rixensart** for the Ardelle "Charles Fontaine" Labyrinth. The author indeed likes to warmly thank **Mr. Charles Fontaine**, 93, for bringing the Chartres labyrinth to his attention. Besides the Ardelle Labyrinth drawing his name, a lithographic work (fig.1) based on the original research stemming from this hint, has been dedicated to him as a tribute.

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If interested, please contact the author by e-mail to address : verbiese@alum.mit.edu .

References

[1] Jacques Hébert, http://www.labyreims.com/e-index.html
[2] Rob Scharein, http://knotplot.com
[3] Hermann Kern, *Through the Labyrinth : Design and Meanings over 5,000 years,* English Edition by editors Robert Ferré & Jeff Saward, Prestel, 2000.
[4] Adrian Fisher, *The Labyrinth Book*, Thames and Hudson, 2006
[5] Jo Edkin, http://www.gwydir.demon.co.uk/jo/maze/chartres.htm
[6] Paul Hildebrandt, http://www.zometool.com
[7] Samuel Verbiese , *Tribute to the Atomium*, Proceedings of the Bridges Conference in London, 2006, where the author hints at labyrinths in the sense of the Atomium being kind of a 3-D labyrinth having inspired the permanent labyrinth of the Sobieski Park in Brussels (also see www.zometool.com/zomeforum).

I cannot give due tribute here to the numerous references that have been consulted on the Internet, searching for keyword "labyrinth" and many variations. A couple were mentioned within the text. Theoretical references are not mentioned either : as a non-mathematician, I leave to specialists, if interested, to dig out possible mathematical nuggets these structures might conceal.

This paper is an outgrowth of part of my poster *Tangramoids, Labyrinths, Knots and other 3-D sculptures coming unexpectedly to life with KnotPlot*, at the joint ISAMA-Bridges Conference 2003, Granada, Spain, July 22-25, was updated on March 1, 2007 and had its English improved thanks to the kind help of **Paul Hildebrandt** on April 25, 2007.
It has been mirrored by entries in the 2007 Bridges Exhibit on Mathematical Art.