

## Amazing Labyrinths, Further Developments II

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### Abstract

In the wake of the art exhibition associated to the Banff 2009 Bridges conference where I showed my 'Chartres Laborange', Eva Knoll suggested I try making other spheres sporting labyrinth designs of hers such as those I referenced in my paper 'Amazing Labyrinths, Further Developments', at the same conference. A first result was shown off-exhibit at Pécs 2010, and I give an account on how it was reached, along with another development **with new 'evident' insight (fun red Ariadne thread in this paper , when read on the CD !)** But before that, I present new results involuntarily induced by Carlo Séquin, based on the St. Omer labyrinth; also, as my Banff Paper lacked images, I show two kinds of Saffron Walden grapefruit labyrinths inspired by discussions with John Sharp.

### Introduction

For more than ten years I have been immersed in the world of labyrinths, thanks to Charles Fontaine (98 now!) who sent me a picture of the Chartres labyrinth in view of my geometrical work. My engineering mind and artistic emotions were immediately and permanently caught, so that I couldn't help recurrently opening up this addiction to the Bridges community. [And this in accordance to a signal hang up of mine, i.e. the importance of epistemological accounts of the labyrinthine wandering process of the creating human mind, this very genesis I indeed believe immensely helps understanding scientific and artistic progress. I so recall here the Ariadne thread on how evolved **(and for those who read this in color on the Conference Disk, also containing high resolution images that are only hinted at for a flavor in this short paper, there is interwoven here another interesting, in red, Ariadne thread I ask your attention to !)**.] It was already mentioned at a poster session at the Granada 2003 joint ISAMA-Bridges conference and formalized in Donostia 2007 with an identical title in my paper 'Amazing Labyrinths' [1], further shown in the associated art exhibition [2] and in the next one during Leeuwarden 2008 [3], then deepened at Banff 2009 in my paper 'Amazing Labyrinths, Further Developments' [4], where I also participated in the art exhibition [5]. In the same 'Bridges spirit', a work was shown in the art exhibit of the JMM 2010 Conference [6], and found a 3D materialization in the art exhibition at Bridges Pécs 2010 [6], as well as off-exhibit there too.

The part of my work on labyrinths which is central in the present paper is as follows : the Chartres annular labyrinth is split along the only radius connecting the outside to the center and morphed into a rectangle then 3D-curved into a cylinder, i.e. you can see the labyrinth as a view into a pipe, an idea further visually clarified by the Saffron Walden labyrinth (actually a  $3/2$  extension of the Chartres design) when half hidden, already suggesting a tunnel with its half circular entrance and exit. Starting from there, it is easy indeed to come up in the Banff exhibition [9] with the spherical extensions, merely blowing up the cylinder closed at both ends, hence my 'Chartres Laborange'. Several Bridges Board members explicitly showed their interest in this work, suggesting to me the developments presented here. In his JMA report on the Donostia 2007 exhibition [8], **Carlo Séquin** highlighted my proof that the St. Omer labyrinth is morphed from the Chartres labyrinth, and mentioned my 'Mini- and Micro-Chartres'

versions, so it was natural to give St. Omer a try on a citrus as well. **John Sharp**, pleased with this 'Chartres Laborange', induced my idea to curl the square in the other direction to blow it into a very different spherical design, which I realized on grapefruit for him from the above mentioned Saffron Walden labyrinth; **Eva Knoll** also cheered the 'Chartres Laborange' it in her JMA report of the Banff 2009 exhibition [9], and suggested I try a spherical rendering of one of her labyrinth designs I referenced in my paper, and that was shown off-exhibit in Pécs 2010 (Fig. 3i), and is explained here, along with new work emerging from another of her suggestions.

### 1. Labycittriztion of the St. Omer Labyrinth and its Mini and Micro Versions

The square St. Omer labyrinth, brought to my attention by Belgian artist and engineer Paul Gonze, is thus gracefully waving around the already involved path layout of the iconic +/-860 design first realized in 1200 in the Chartres cathedral. I cut paper images of it and of the 'Mini and Micro variations' (Fig. 1a) along the bottom half vertical and the diagonals, and rearranged them upwards like wings to form horizontal strips (slightly overlapped to eliminate useless lengths). These non symmetric rectangular labyrinths (Fig. 1b) further curled into cylinders (Fig. 1c, d) as a kind of 'dignitary hat, necklace and bracelet' finally get inflated to decorate half spheres as the complexity sits on the equators. Two of them, placed in opposition, vertically and also circumferentially (if the harmonic symmetry of the successive quadrants making up the emblematic Chartres central cross have been properly retained during the overlapping, Fig. 1d), complete the spherical surface, with the additional feature that the four orthogonal axes align nicely, in pairs, opposites, sporting again, *surprise ?*, the typical cross, square (becoming a circle here) and dot of the St. Omer design, when seen from above or from below (Fig. 1e).

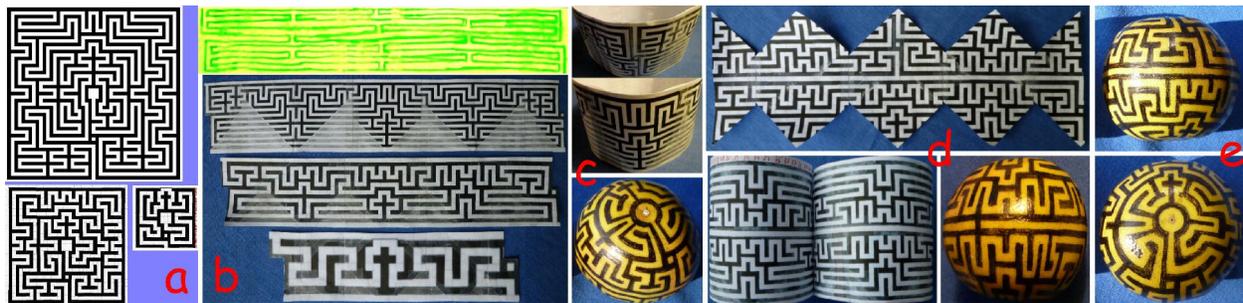


Figure 1. St. Omer labyrinths, in strips, 2 in cylinders, comparison wrong and right, and 'Mini' citrus.

### 2. Two Grapefruitizations of the Saffron Walden Labyrinth

The inflating onto a sphere of the previous morphing of the Saffron Walden labyrinth first into a square, and then curled in orthogonal directions, produces two labyrinths that were shown during the presentation in Banff, but not published. Here are sketches of the quite straightforward preparatory work (Fig. B1), and of the obtained citri, before and after drying, (Fig. 2b, c).

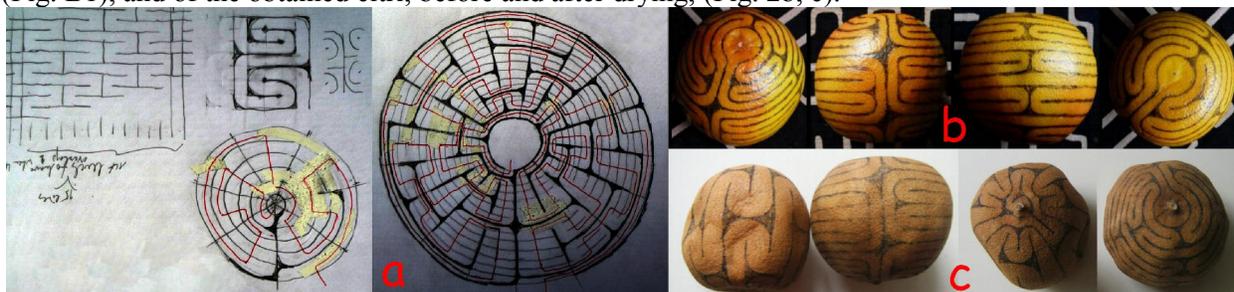


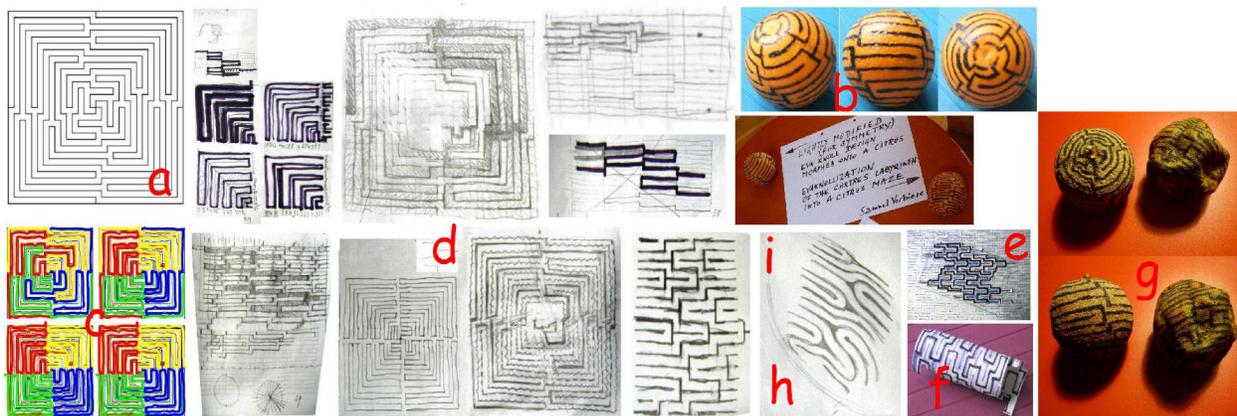
Figure 2: Saffron Walden grapefruit labyrinths, alternate layout, fresh and dried.

### 3. *Evaknollization* of the Chartres Labyrinth into a Citrus Maze

Eva Knoll's maze design (Fig. 3a), created similarly to her work Jie Xu and Craig Kaplan cite in [10] needs first to be thoroughly understood. The concentric squares, 15 'belts' indeed, often called 'circuits' in 'labyrinth speak', could readily be made circular, but for the time being, I kept them square. I used four colors to visually identify the four nested paths, and made some successive inversion rearrangements (which I later found in [10]) to untangle and end up having only one color in each quadrant, this provided clues of some of the 'mechanics' of this design (Fig. 3c). The more apparent symmetry still lacked an identical treatment of the outer and central parts, as what we seek is that when turning the citrus upside down you'd get exactly the same pole view. Here, the four paths join in the middle, yet at the outside they run along a last quarter. Trying to represent the phenomenon on a stretch of 4 contiguous squares, the upper line representing the outer perimeter, I figured out that the under line should represent a not yet existing (or rather vanishing) inside square, observing that it was possible to add a 16<sup>th</sup>, Nr 0, inner circuit. So, to solve that pole symmetry, I started filling more envelope backs with sketches (assembled as mere hints in Fig. 3d), but re-drawing the four quadrants in a sequential way, I lost sight of the objective as it immediately caught my renewed attention in another direction: it showed a basic *pilgrim step*, with two steps forward and one backward (like in the 'Echternach Pilgrims', where they stepped three forward and two backward), something I found also to be present in the Chartres Labyrinth (see [1] and [4]). This unicursal labyrinth path is further transformed into a multicursal maze (commonly accepted distinction: single no-choices continuous meandering/wandering line with one central dead-end, vs. multiple lines with choices, splits, and multiple dead-ends), with one extension back and one forth. The meaningful material can be found as part of an infinite regular lattice pattern (Fig. 3e). In this case it is no longer a square, but a more complicated sheet that can be folded, and where spikes on all sides can be fit into one another during the curling into a cylinder (Fig. 3f) and the inflating process into a sphere (Fig. 3g).

Very pleased with previous finding I resumed concentrating on the pole symmetry, trying to 'complete' the labyrinth in the center with a similar scheme, but got annoyed by the 'ridges' explained in [10], that prevented me reaching the center in harmony. So I went back to the series of transformations of the labyrinth (Fig. 3c) and rearranged a bit the central section, which eventually got to the draft citrus of which I give three views (Fig. 3b), and that looked quite nice to me. One can notice that the 'ridge' effect leads to some kind of 'torsion' of the cylindrical design that follows in the sphere, giving it extra plastic viewing dynamics.

I further envisioned the same scheme could be rounded (Fig.3h). Finally, I also wanted to curl the rectangular transform in the other direction before blowing it into a sphere, but there is too much information in there to be adequately readable on a citrus, as the line would be very fine.



**Figure 3:** Development of the Eva Knoll labyrinth slightly symmetrized for the citrus, fresh and dried.

#### 4. New Developments : Projection of Labyrinths to Spheres through Polyhedra

Directly related in fact to some work I envisioned in [9], hence the similar subtitle, Eva Knoll suggested further work during a subsequent discussion, as follows: "The icosahedron can be seen as two pentagonal pyramids attached to the two opposite faces of a pentagonal antiprism, i.e. two parallel pentagons at a distance to each other and oriented in such a way as to be rotated by  $[2\pi/10]$  to each other around their central axis, and joined by 10 equilateral triangles (a drum-like polyhedron because it looks like one with the strings zig-zagging around). The same thing can be done with square pyramids and a square anti-prism, and, adjusting the angles and lengths so that the triangles on the pyramids are coplanar with their adjacent triangles on the antiprism (which is impossible...), you would get a shape that has 8 'rhombi' (which can be thought of as distorted squares...) and you could then put one of my labyrinths on four of these (that meet at a vertex of the pyramid) and another copy on the other 4. The whole thing could then be projected onto a sphere (which renders the thing possible!). Perhaps another way to think of it is to have a zig-zag equator made of 4 zigs and 4 zags, then join the vertices nearer each pole to it, giving you 8 4-sided regions of the sphere, that meet in 4 at the poles. These sets of 4 could then contain the four colors used in "Eva's transforms side by side" (Fig. 3c), for a total of two complete Eva-labyrinths..." I tried just that and got the draft where we can imagine two of Eva's designs filled in, and eye-like voids blackened, for a nice view (Fig. 4a, b) [11]: this brings an alternate insight: an annular or square rubber labyrinth becomes a sphere by just pulling down from an initial tangent position [12], yet other 'curling' is harder. Above playful drum metaphor (I enjoy using myself during geometry animations for children) becomes here a posteriori all the more relevant when considering the stretched "rubber mazes" somehow echo the drum membranes... A further development could be, starting from the Atomium sphere skin as a Disdyakis dodecahedron (another pet subject of mine) or from a rhombic dodecahedron blown up into a sphere, filling the rhombs with Eva's mazes.



Figure 4: Mandarin sketch and final grapefruit with twice the same Fig. 3 Eva Knoll maze pattern.

#### Acknowledgments, Copyrights and References

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