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St Louis Arch Scale Model Kit

Abstract

The St Louis Arch Scale Model Kit provides the builder with an experience of solving the engineering problems faced by Eero Saarinen and his engineering team in the form of a Scale Model Kit of the St Louis Arch

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Background/Summary

PRIOR ART
This Example is Not a Kit
[0001] a. Gateway Arch St. Louis 3D Printed Architectural Model plus Stand, https://www.etsy.com/listing/1200394317/gateway-arch-st-louis-3d-printed
This Example is Not a Kit, Either
[0002] a. 3D-Printed GATEWAY ARCH Model, Eco-designed St Louis Missouri Monument

Landmark Souvenir; 3D Printable Gateway Arch—St. Louis, Missouri by MiniWorld3D (myminifactory.com)
Nor is this Example a Kit
[0003] a. 3D Printed Scale Model Of The Gateway Arch in St. Louis, https://www.etsy.com/listing/1099837190/3d-printed-scale-model-of-the-gateway?click_key=c8b474df87a817f867243ccbdeb9bbec325d54d5%3A1099837190&click_sum=67ae88eb&ref=sold_out-10&cns=1
BACKGROUND OF THE INVENTION
[0004] There exists no kit for assembling a scale model of the St
[0005] Louis Arch. The above web links [0001], [0002], point to items which are small 3-D printed solid models of the whole arch, no assembly required. These are not patented, in any case. This ST LOUIS ARCH SCALE MODEL KIT provides an accurate disassembled scale model of the St Louis Arch. The builder learns how the arch was designed, solving the same engineering challenges faced by designer, Eero Saarinen and his engineers.
[0006] The mathematics of the arch are well known [See paragraphs [0006]-[0008], below]. But, the Prior Art examples, above do not solve the problem of dividing the arch accurately and precisely into sections of varying angles, height and width which can then be put together by the end user to form an entire scale model arch of smooth edges and surfaces, visually and tactilely.
[0007] How the Gateway Arch Got its Shape, Robert Osserman, s00004-010-0030-8.pdf, https://link.springer.com/content/pdf/10.1007/s00004-010-0030-8.pdf
[0008] THE MATHEMATICS AND ARCHITECTURE OF THE SAINT LOUIS ARCH, by William V. Thayer, Copyright© 1982, © 1988 and © 1998, William V. Thayer, All Rights Reserved, https://www.jug.net/wt/arch.htm
[0009] Owner's Manual for the Gateway Arch, St Louis MO, https://www.jug.net/wt/archcgs.htm
SUMMARY OF THE INVENTION
[0010] A kit of equilateral triangular wedges which, when assemble, form an accurate standing model of the St Louis Arch, providing the builder with objective reality on the arch's design and construction.

Description

BRIEF DESCRIPTION OF DRAWINGS
[0011] FIG. **0** A photograph of a finished [built] St Louis Arch Scale Model Kit, mounted on LEGO-COMPATIBLE baseboard;
[0012] FIG. **01**-FIG. **71**: Sections 01-71 of the St Louis Arch Scale Model;
[0013] FIG. **72**A View from above of one of the pair of BASE pieces for securing the arch to a stable foundation, showing the space into which the bottom section of each leg [FIG. **71**] fits;
[0014] FIG. **72**B view from beneath of one of the pair of BASE pieces for securing the arch to a stable foundation, showing the LEGO-COMPATIBLE bottom surface and two optional screw holes for securing down to a sub-base;
[0015] FIG. **72**C [Used in the Arch Model's assembly] NOTE ON PRESSING BOTTOM SECTION INTO BASE: When assembling the arch and setting the bottom section (FIG. **71**); into the base (FIG. **72**), the angle of said segment [and the way it tapers] prevents the corners of said bottom section from squeezing down into said base. The sides and back “lean in” and are narrower the further up you go than the dimensions at the bottom (the bellow ground part). The shape begins at the bottom back edge and extends up vertically to the height of the segment. Edge to edge, it is NOT vertical, but follows the subtle curves of the sides as they taper inward. This wedge shape (FIG. **72**) is subtracted from the top of the base [FIG. **72**A], providing relief to allow the pieces to snap together.

[0016] FIG. **73**: Flow chart summarizing of the process for generating the individual sections of the St Louis Arch Scale Model, described below.

DETAILED DESCRIPTION OF THE INVENTION

Assembly of the St Louis Arch Scale Model Kit

[0017] a. lining up in proper order and orientation all the Arch Segments [2 each of FIG. **01**-FIG. **71**], plus the pair of Arch Bases [FIG. **72**A and FIG. **72**B]. Note: each segment's number is printed on said segment's inside dorsal surface, oriented facing up. [0018] b. Stringing Tensioning Cables through the Tension Cable Cylinder in each of the 3 vertexes of each Arch Segment (2 each of FIG. **01**-FIG. **71**), and through the **3** Tension Cable Cylinders in each Arch Base [FIG. **72**A and FIG. **72**B]. [0019] c. Applying sufficient tension to the **3** Tensioning Cables, securing said cables to the outside of each Arch Base [FIG. **72**A and FIG. **72**B].

[0020] See [FIG. **74**] Flow chart summarizing the process for generating the individual sections of the St Louis Arch Scale Model. [0021] d. Build and execute the c# .net software project [0019] to [0022] i. calculate the dimensions of each arch section. [0023] ii. output an OpenSCAD script file to render said section in 3 dimensional space. [0024] e. PowerShell script to Convert said OpenSCAD script file into a stereolithography .stl file.

(requires Powershell 7.4 and Openscad 2021.01 installation); [0025] f. Slice said stereolithography .stl file(s) for 3-D printing (requires the slicing provided with your 3-D printer). [0026] i. Select a number of .stl files, assuring they will fit on the given 3-D printer's stage. [0027] ii. Execute the Printer's ‘Slice’ utility. [0028] g. 3-D print each section, in batches. [0029] i. Load the output from the Slice Utility (if necessary). [0030] ii. Initiate the printing of this batch of Arch Sections (section is synonymous with segment).

ArchModel c# NetCore Project Summary

[0031] Each leg of the St Louis Arch Scale Model Kit is divided into 71 Segments, to represent the legs of the actual stainless steel-clad Arch on the Mississippi west bank. The section heights of the Actual arch could not be determined with certainty from information available on the web due to conflicting data. The number of segments and claimed segment heights from the web do not add up to the proper segment count (142) for the overall Arch's height and width: 630 units

Determining Proper Segment Heights is a NOT-SO-OBVIOUS Part of the Program

[0032] a. The St Louis Arch Scale Model kit can be produced with either of the (below) Fixed-height Segmentations. In addition to this fixed height segmenting method, the St Louis Arch Scale Model Kit provides a Variable section height method. In this method, the topmost pair of sections [FIG. **01**] are both 6 or 8 units in height, while each succeeding (lower) section grows by a factor of ˜0.075 units to arrive at a 12 unit height for the bottom section (FIG. **71**). This result may be different from the Actual arch, but it closely resembles the original Eero Saarinen blueprint as represented in the diagram from the ‘Owners Manual’ [0008 (above)]. It may also achieve a more fair curve in the resulting assembly. [0033] b. Both methods use CrossSections to define each Segment's upper and lower bounds. Starting with the top segment, the X and Y location and dimensions of each segment's lower CrossSections is determined by repeatedly adding a very small deltaX distance (0.001 units) to the bottom of the previous segment, until the segment's prescribed height (along the dorsal surface) is reached. The next segment's upper CrossSection is one deltax greater than the lower CrossSection of the segment above. On average, about 4,225 arch cross sections are calculated in the process of defining each Segment's bounds. [0034] c. GatewayArch.Model.CreateUniqueArchLegSegments( )—This is the procedure that performs the arch segmentation using one of the two general methods: [0035] i. Method 1. Start with a fixed number of upper segments of a pre-determined height (6 or 8 units) then generate as many sections of a larger height (12 units) until the desired number of segments (71) is reached; These are the combinations of fixed Segment heights that work to produce the correct 71 Segments per leg (the topmost pair of Segments are either 6 or 8 units long):

TABLE-US-00001 1. individual overall 2. number of section section arch 3. sections type height

length 4. .sub.——.sub.——.sub.—— .sub.——.sub.——.sub.—— .sub.——.sub.——.sub.—— .sub.——.sub.——.sub.—— 5. 16 Top 6 96 6. 55 bottom 12 660 7. 8. 71 total 756 9. 10. 11. 24 Top 8 192 12. 47 bottom 12 564 13. 14. 71 total 756 [0036] ii. Method 2. Start with a Segment height (6 or 8 units) and grow each succeeding Segment by an appropriate constant growth factor until the desired number of segments (71) is reached and the overall arch height reaches its correct 630 units; [0037] 1. The SegmentHeightGrowthFactor is an arbitrary value, factored to produce the correct number of segments, with the correct segment side width of 54 units at ground level. Ground level occurs somewhere in the middle of the bottom section [FIG. **71**]. [0038] d.
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[0039] Segment class . . . Contains the UpperCrossSection and LowerCrossSection properties, as well as a collection of Polyhedrons representing the East, West and Back walls of the Segment. [0040] a. GetNextCrossSection( ) procedure used during the segmentation process. [0041] b. GenerateScad_Polyhedrons( ) procedure appends OpenScad script to a StringBuilder. This script will render the Segment when opened in the OpenScad program.

[0042] CrossSection class . . . Is responsible for calculating all the mathematics given in the 'Owners Manual' [0008, above]; such properties as the centroid, introdos and extrados points, outer and inner vertex points of the equilateral triangle, etc. which describe the CrossSection;

[0043] Polyhedron class provides structures congruent with the OpenSCAD polyhedron command;

[0044] Geometry class provides helper methods for calculating distances, slopes and angles between objects in 3-D space;

Claims

1. A kit from which to assemble a SCALE MODEL of the St Louis Arch [FIG. **0**], comprised of pairs of 71 unique triangular wedge pieces comprising each leg of the arch, said legs resting in a pair of base pieces, held together A) with tensioning cables or B) with lego-compatible interlocking surfaces.