MIT Class 6.S080 (AUS)

Mechanical Invention through Computation

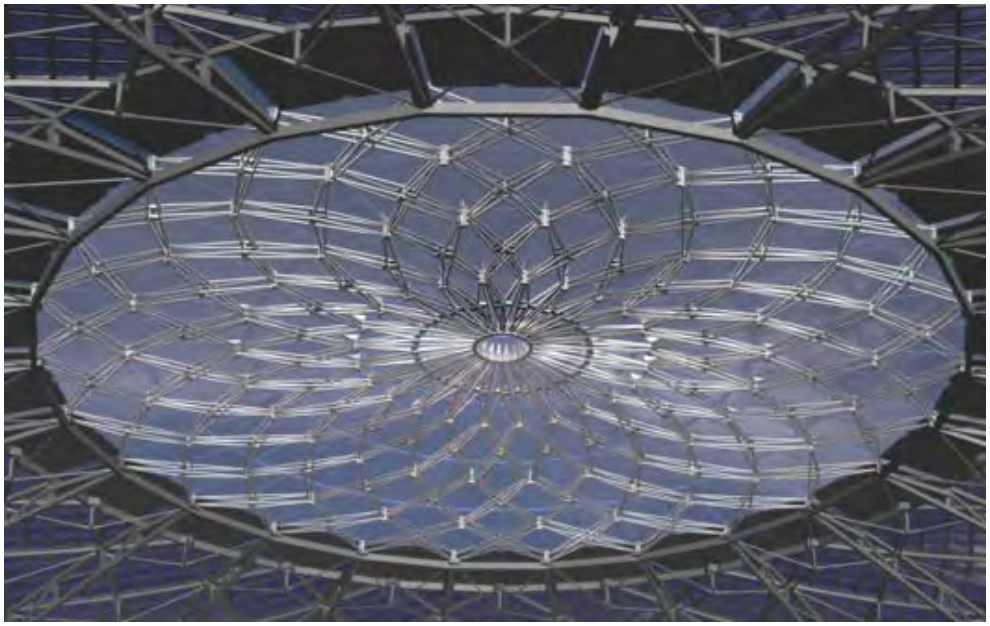
Iris Structures

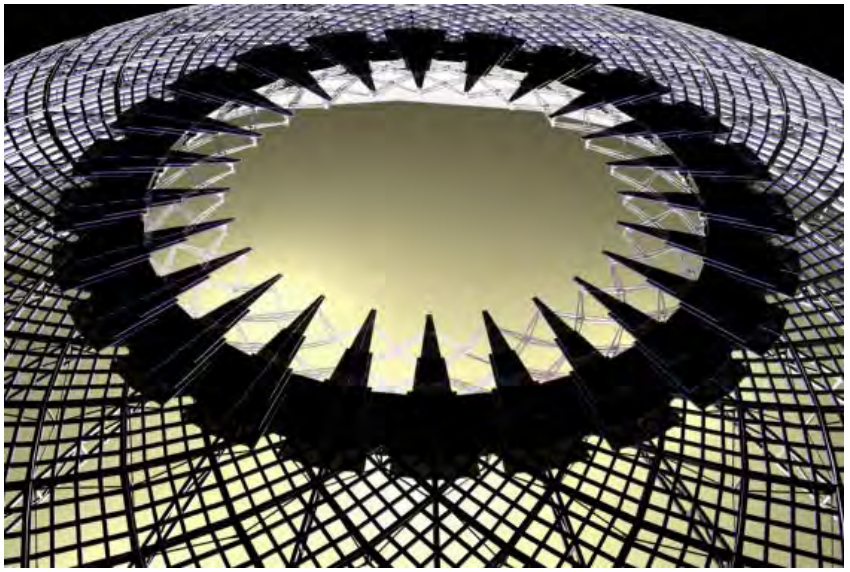
Innovative Technology

Radial Aperture (Iris)

HOBERMAN

ADAPTIVE BUILDING INITIATIVE

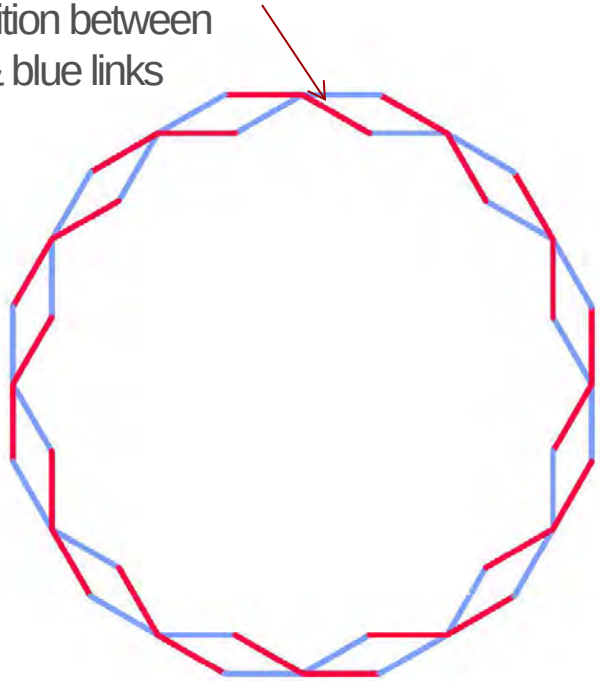




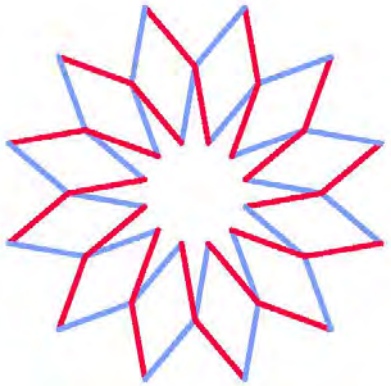
Iris Structures

- Circle linkage, 12 scissor pairs

Note collinear
condition between
red & blue links



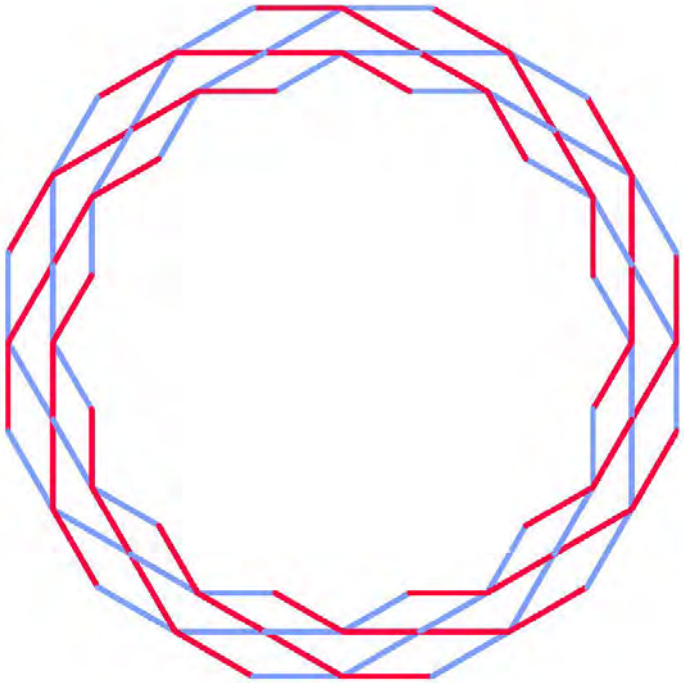
retracted



extended

Iris Structures

- Connect 2nd circle linkage to 1st
- Outer pivots of inner linkage connected to inner pivots of outer linkage



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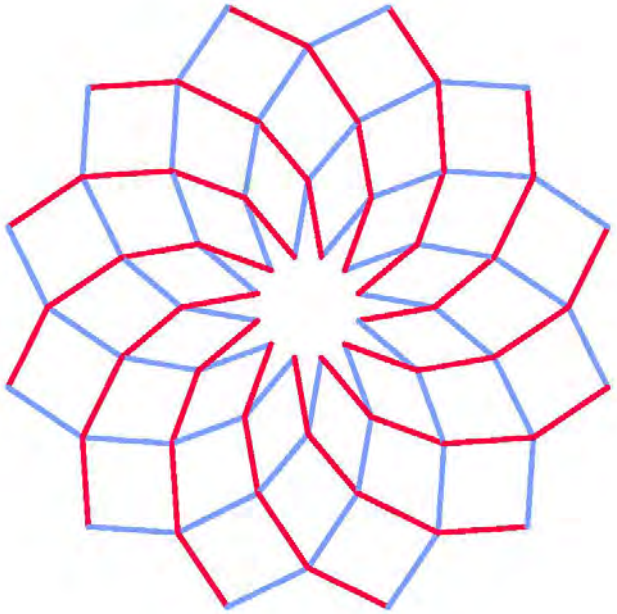
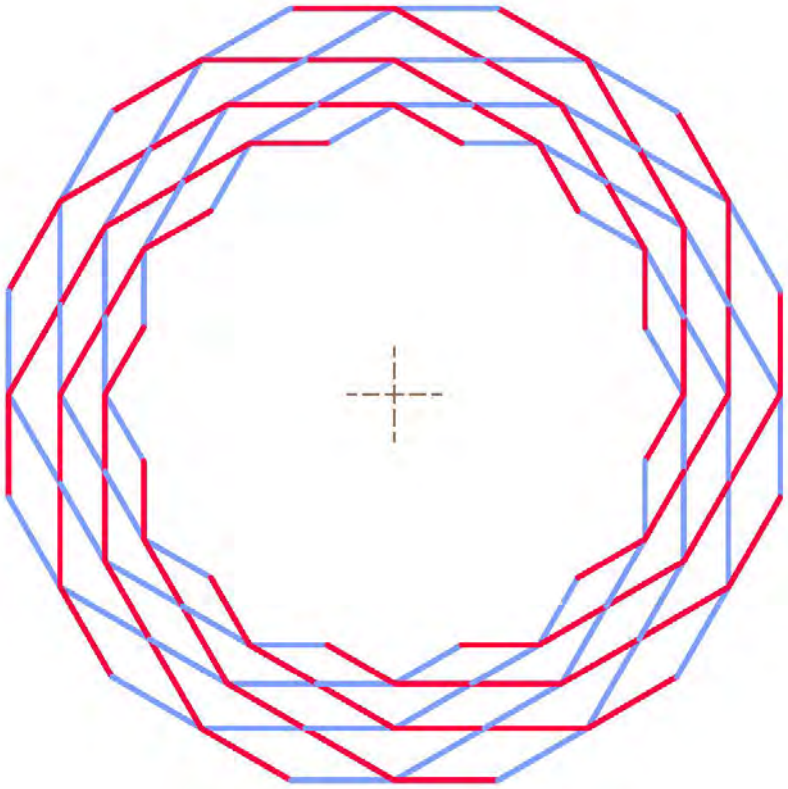


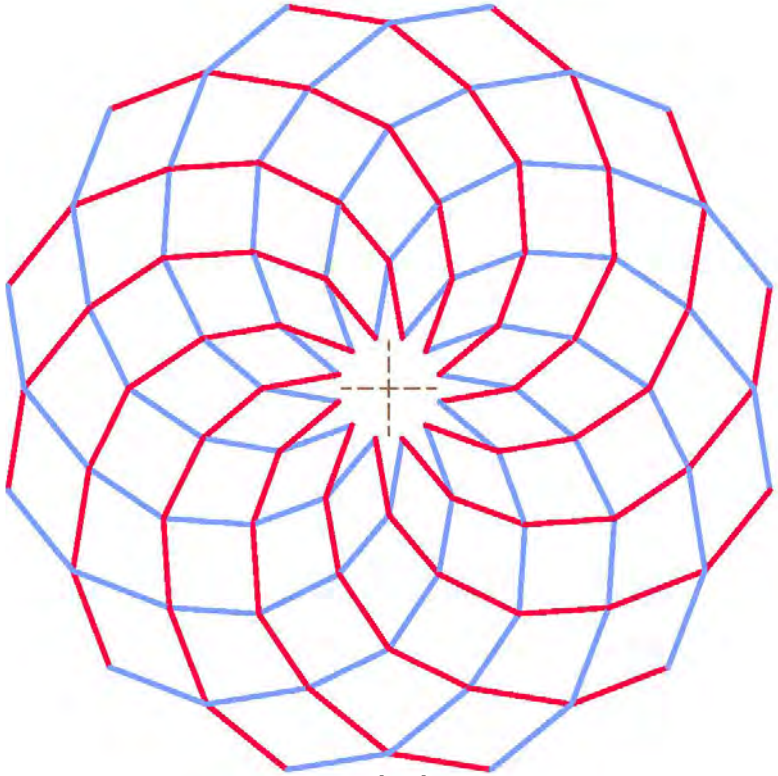
extended

Iris Structures

- Third linkage connected to other two linkages



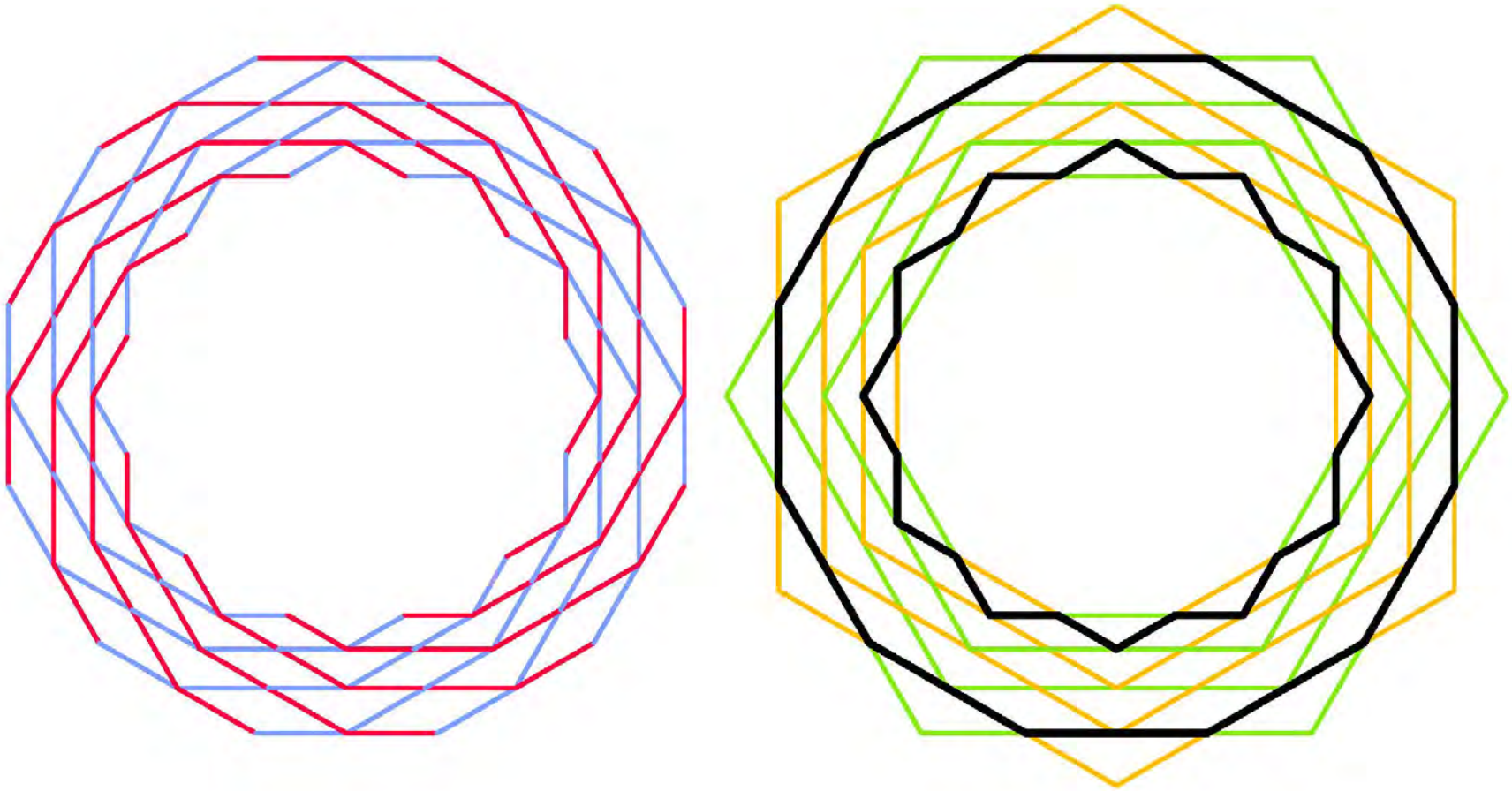
retracted



extended

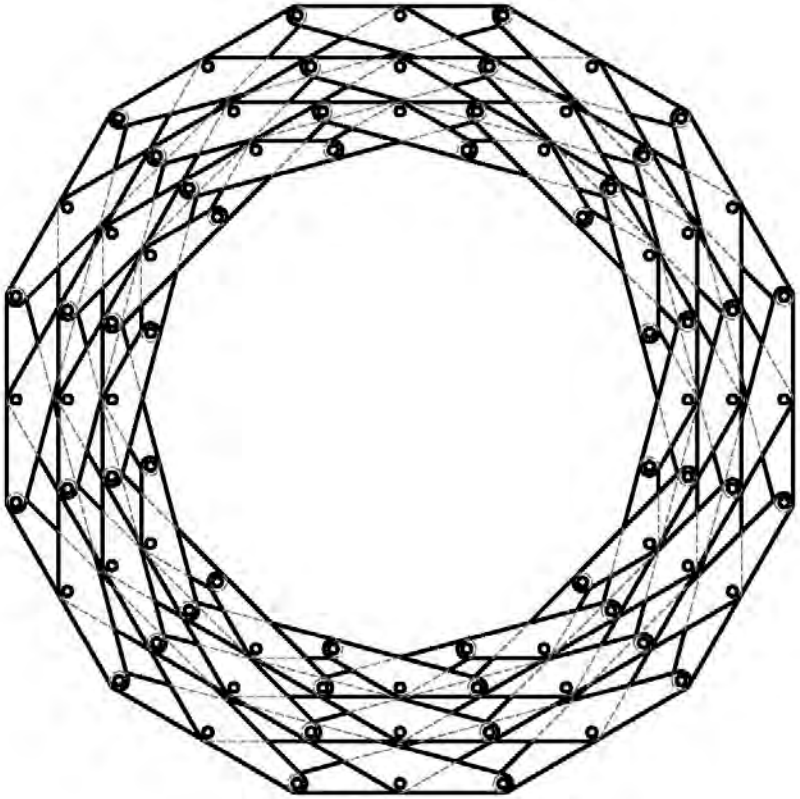
Iris structures

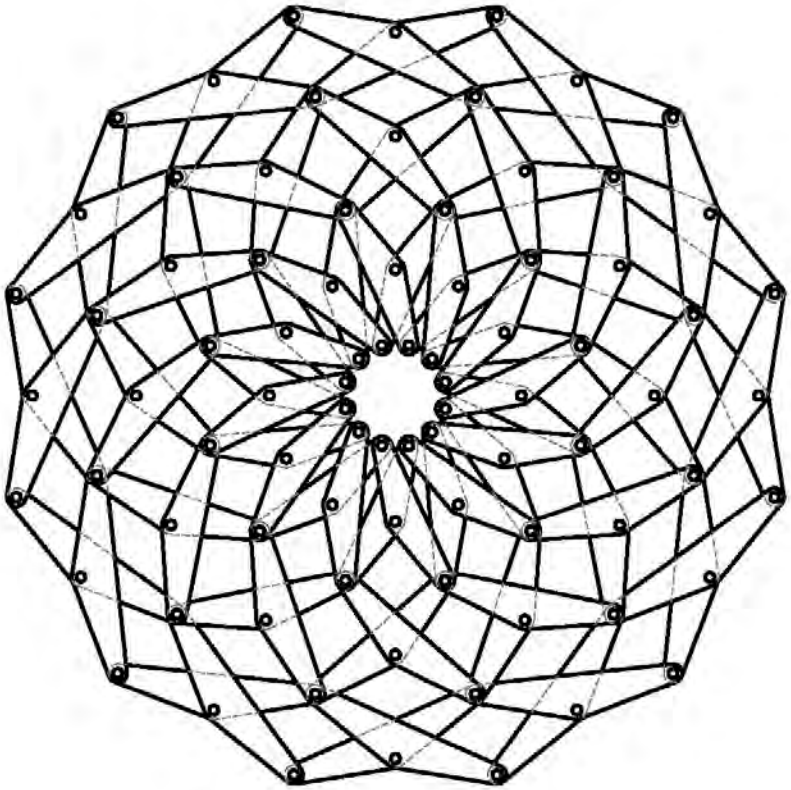
- Alternate view of folded geometry – interlocking hexagons



Iris structures

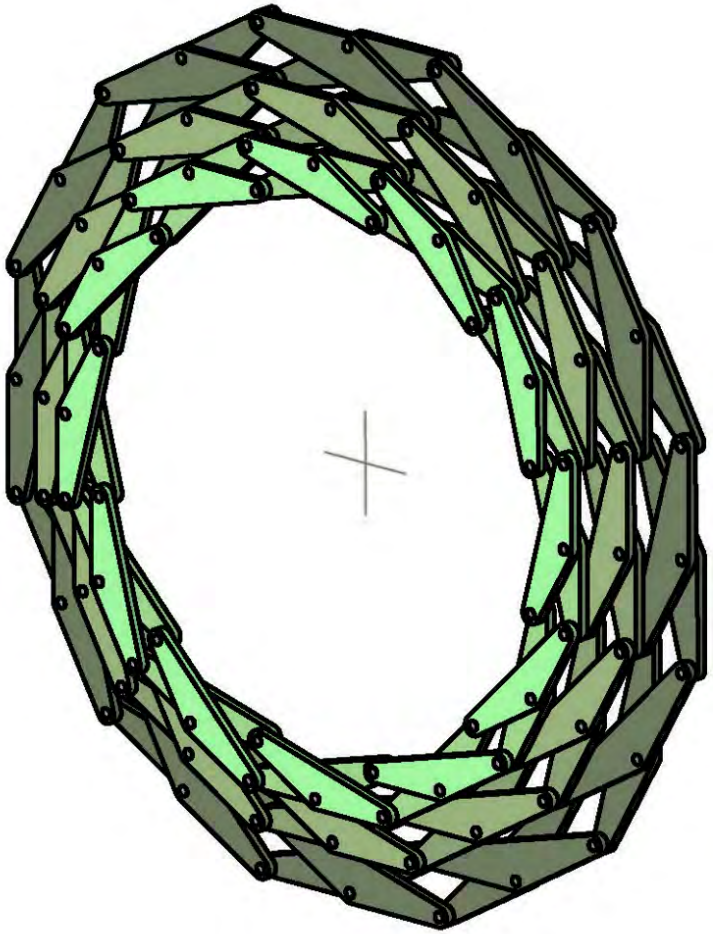
- Constructed circular iris

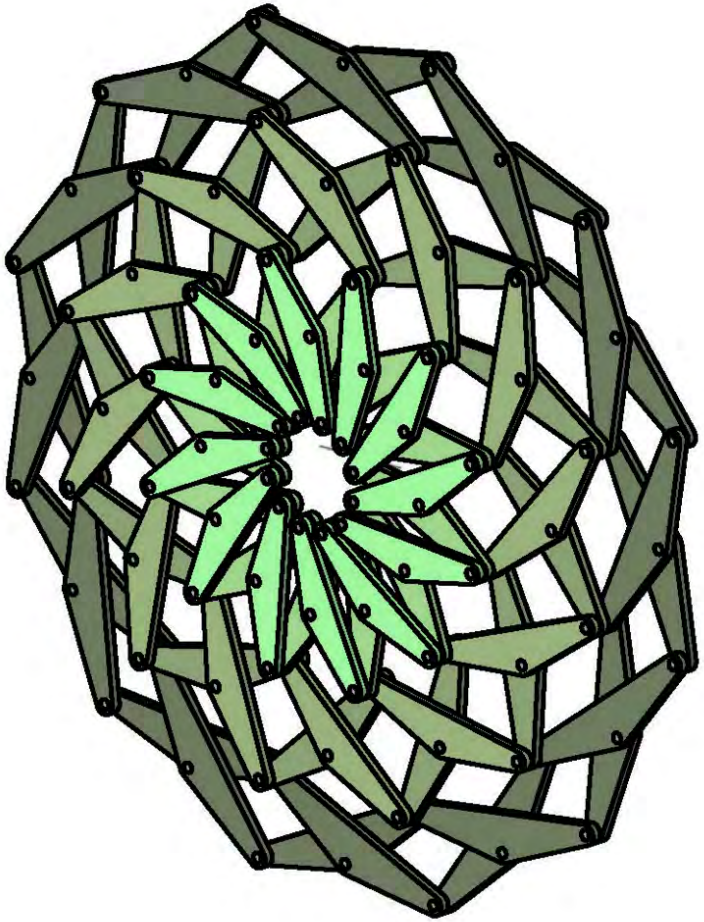




Iris structures

- Constructed circular iris – note that pivots go through four links (except for inner and outer perimeter, which go through 2 links)





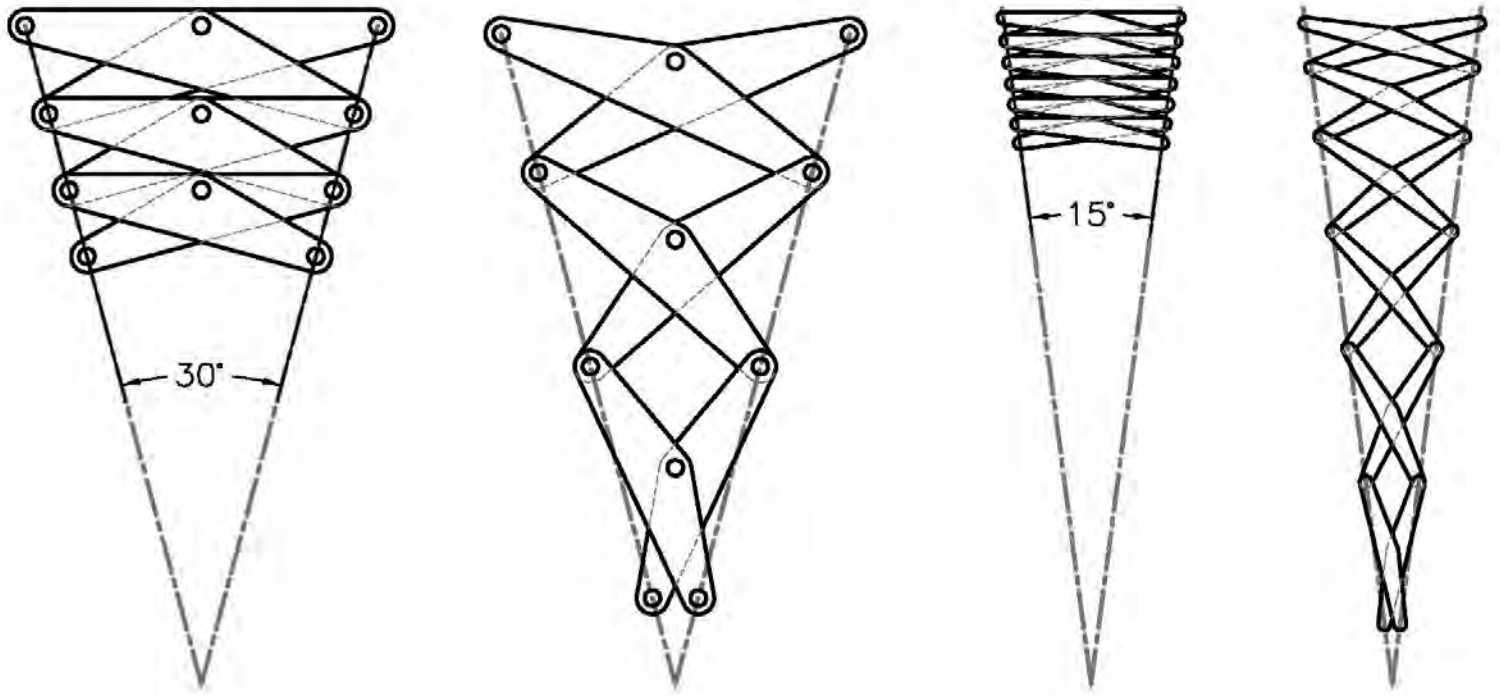
Iris structures

Comparison between two iris scissor constructions

note correlation

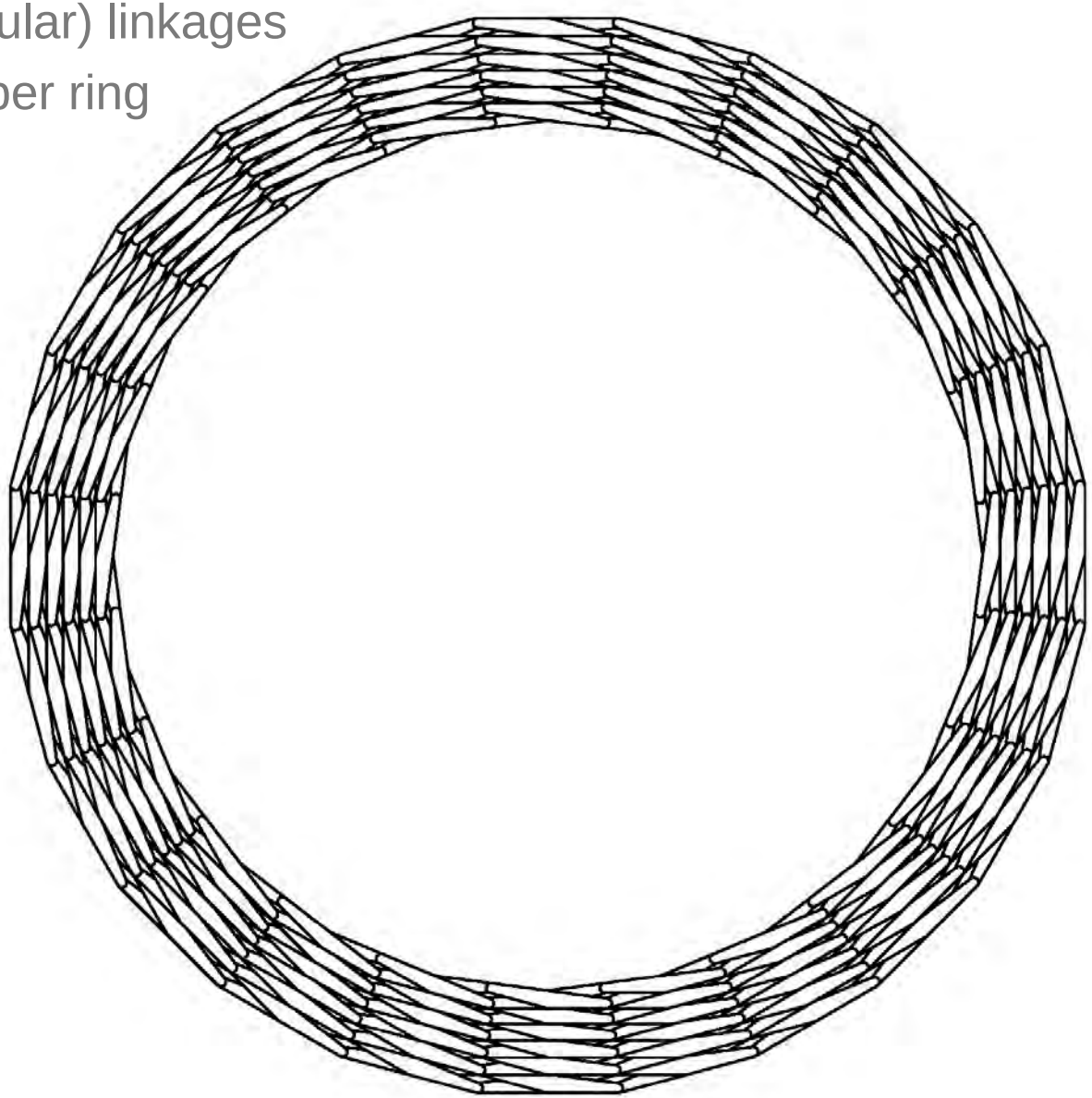
- 30 degree angle has 3 scissors
- 15 degree angle has 6 scissors

Generally, smaller angle has more scissors and achieves greater compression ration when retracted



Iris structures

- Six ring (circular) linkages
- 24 scissors per ring



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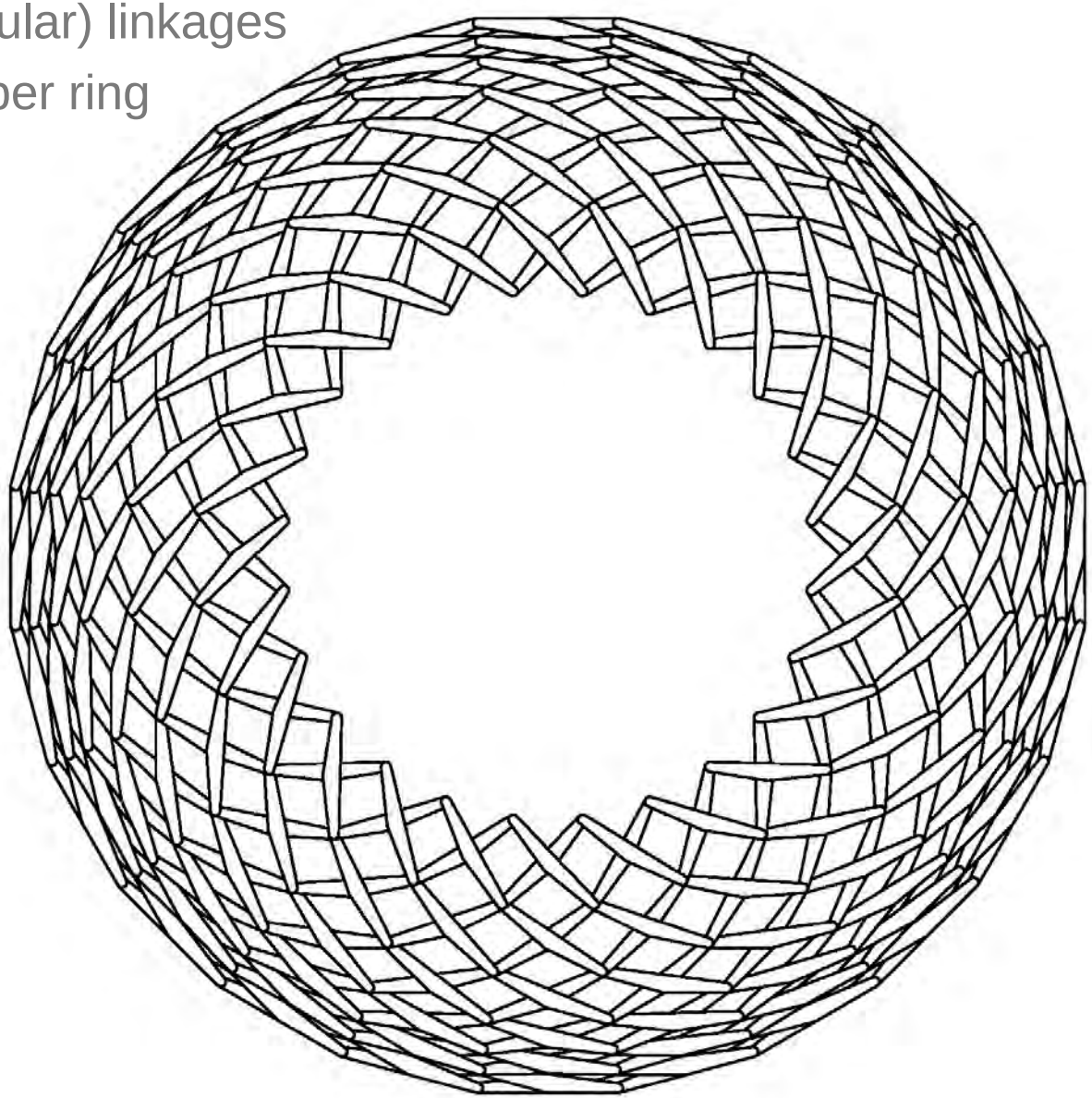

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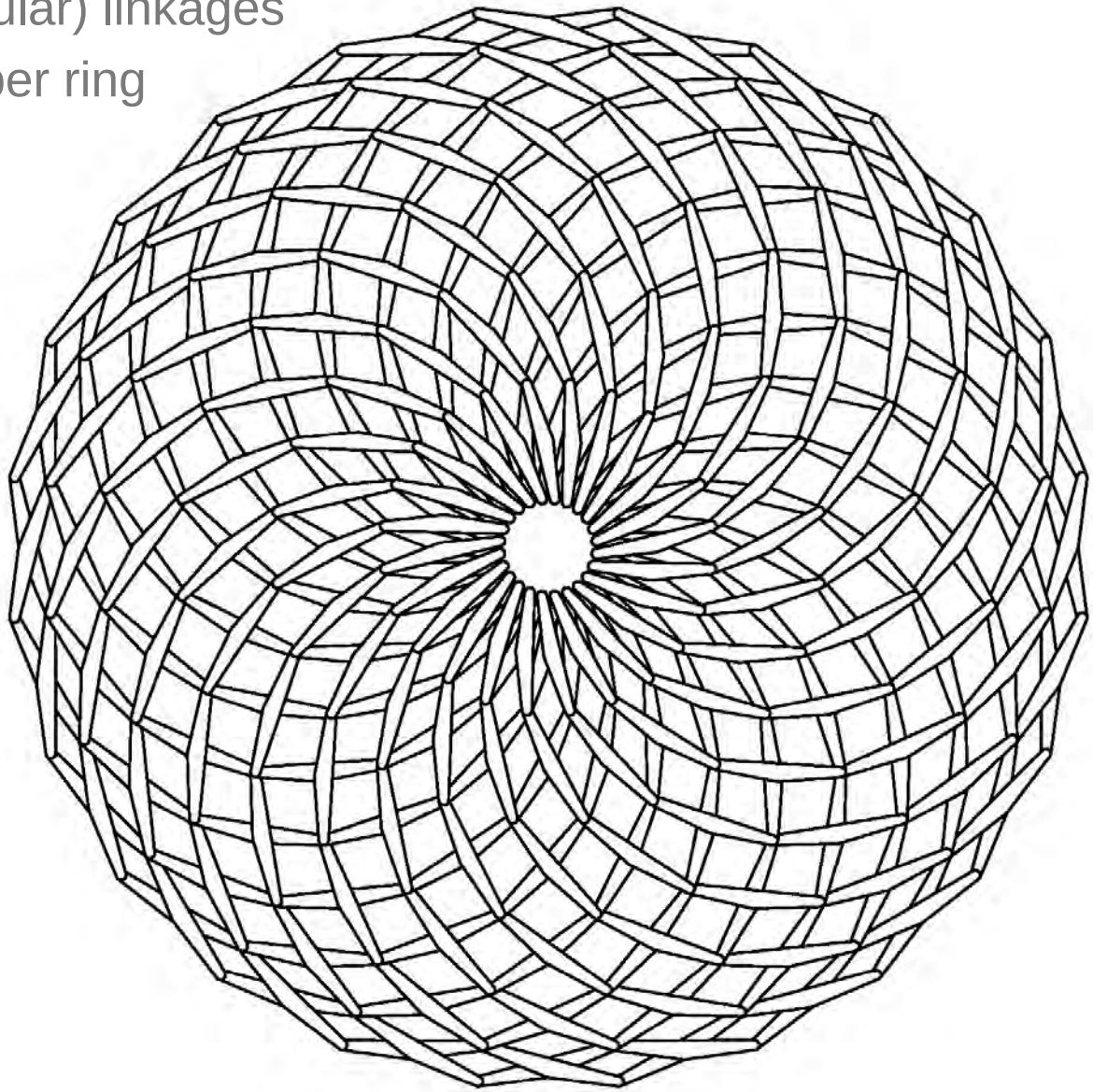
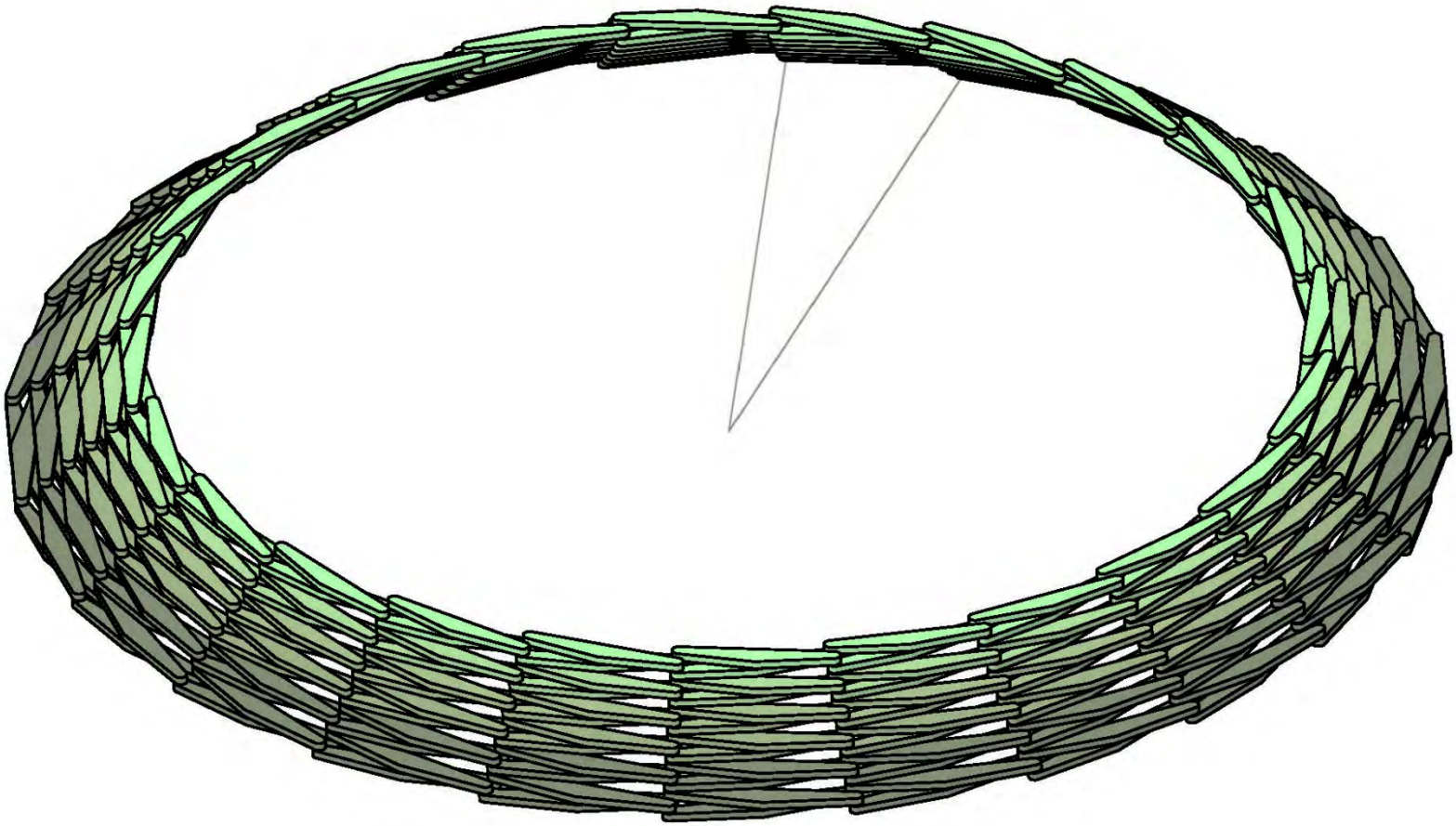
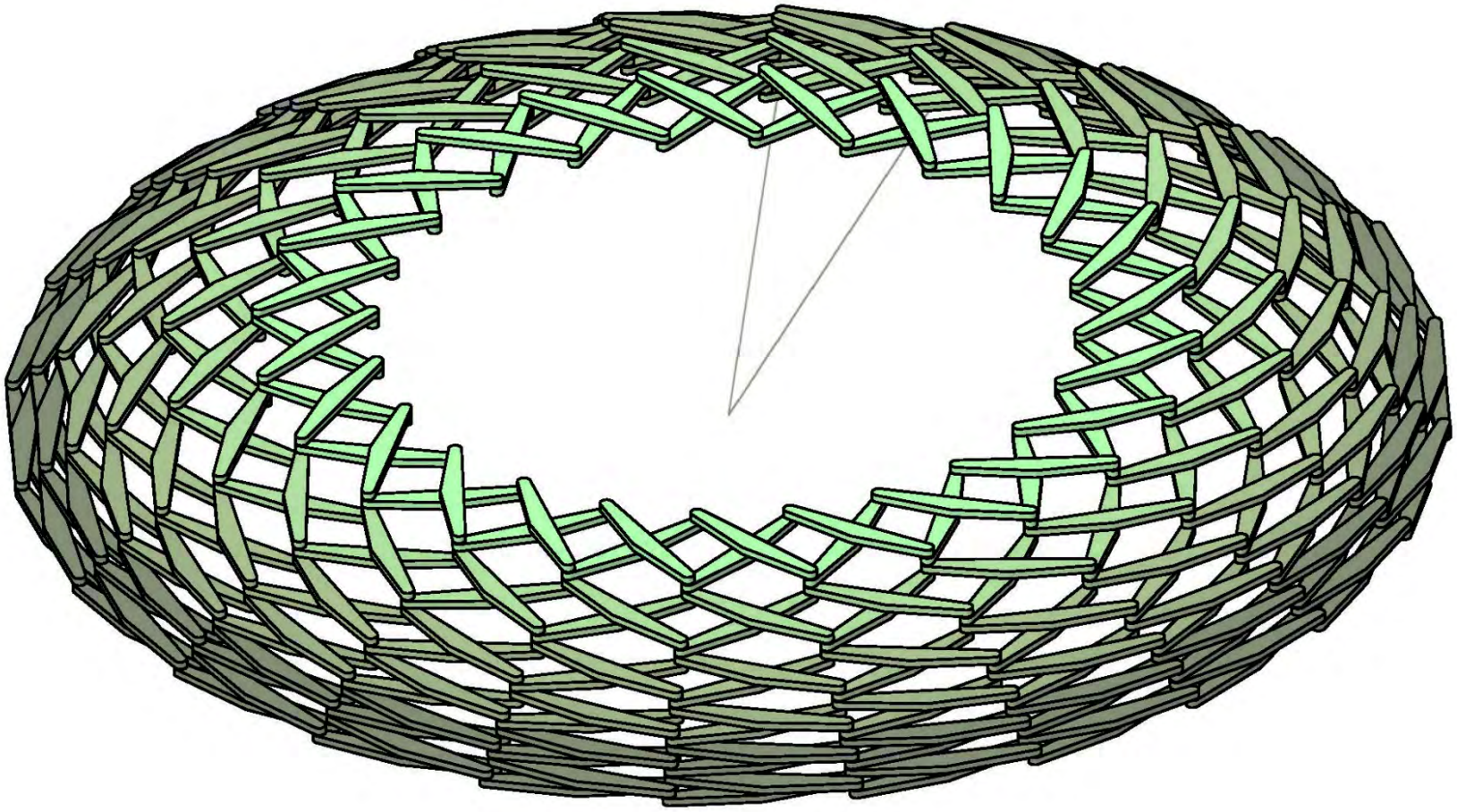


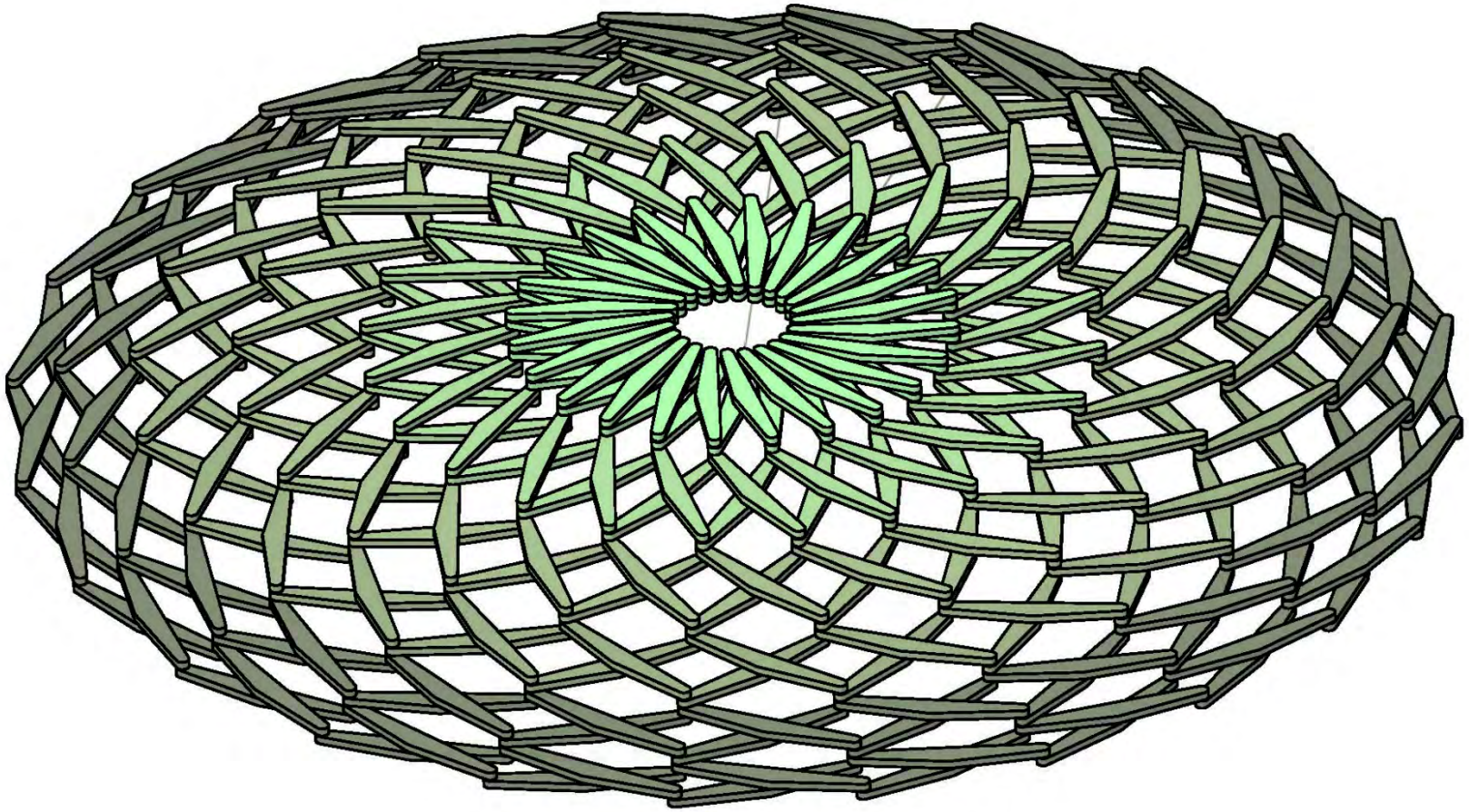
Iris structures



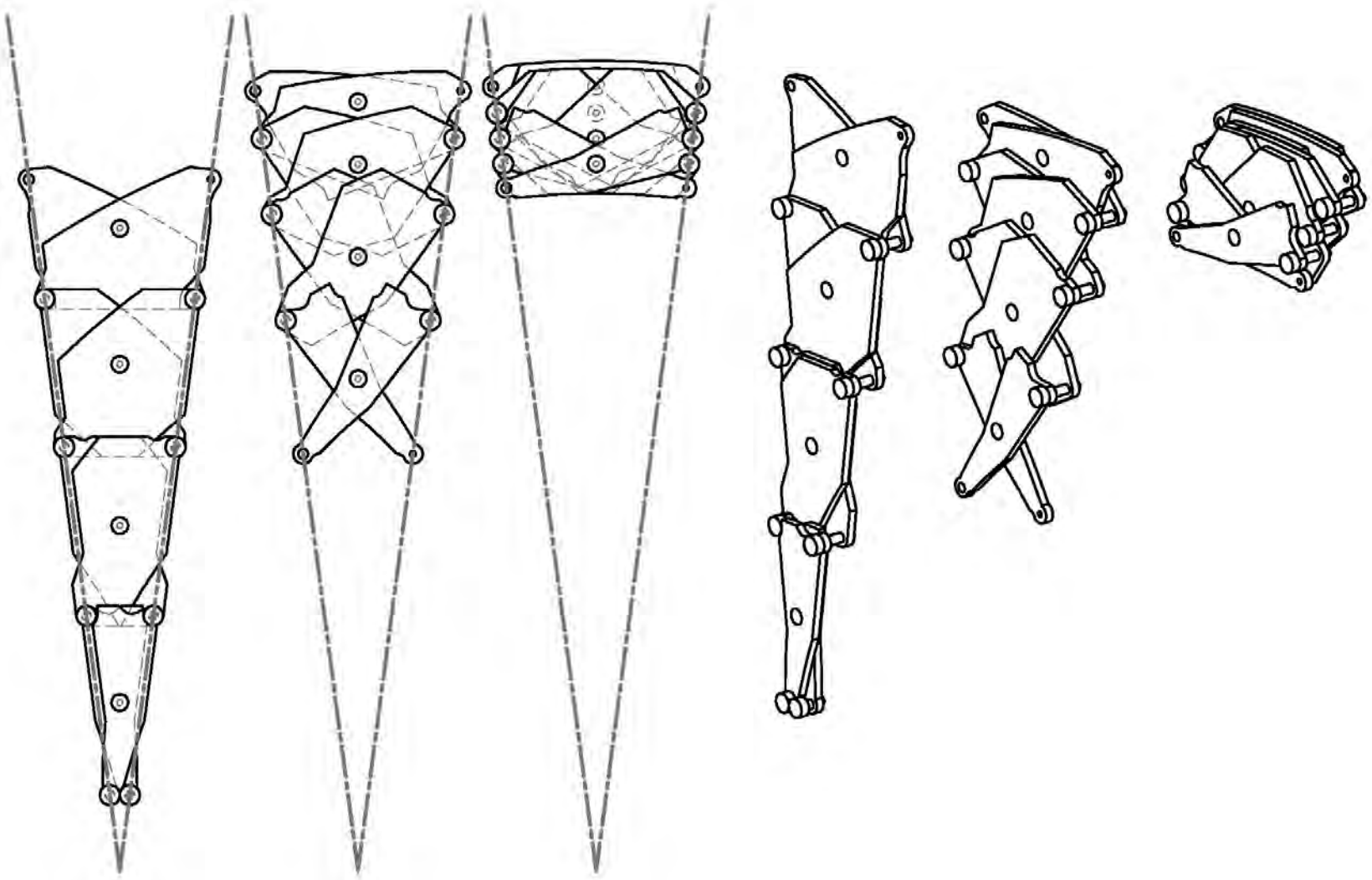
- Iris structures



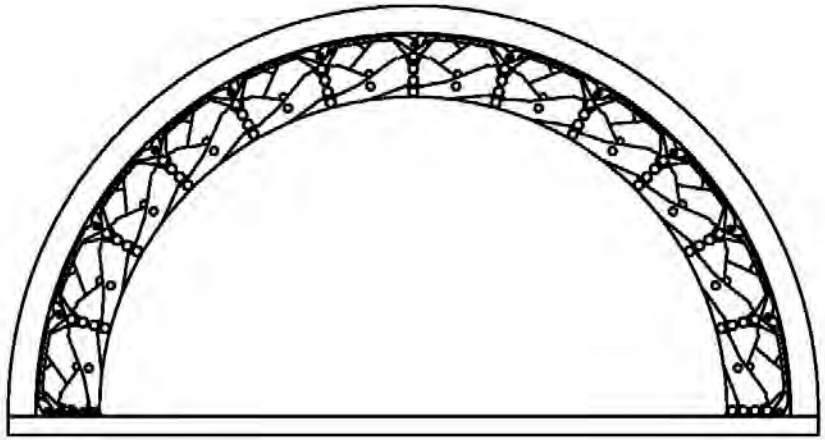
- Iris structures

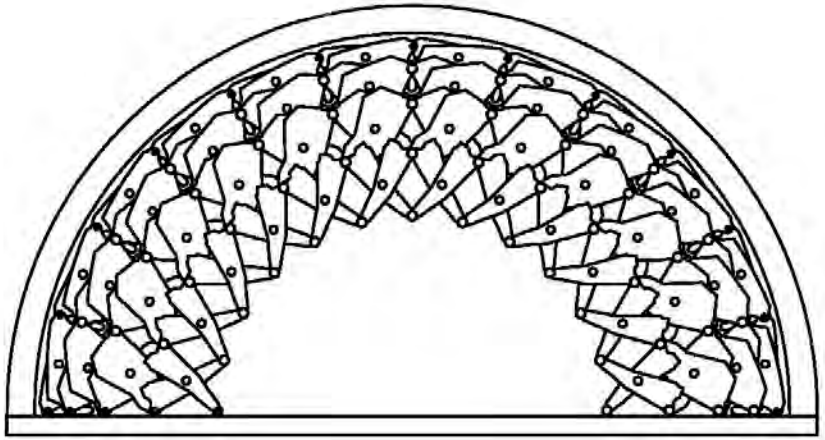


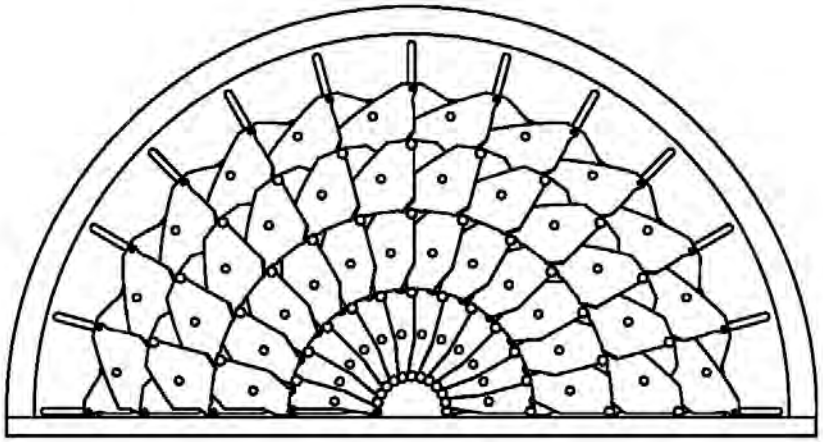
Iris using links as covering panels



Iris curtain







Structural approach

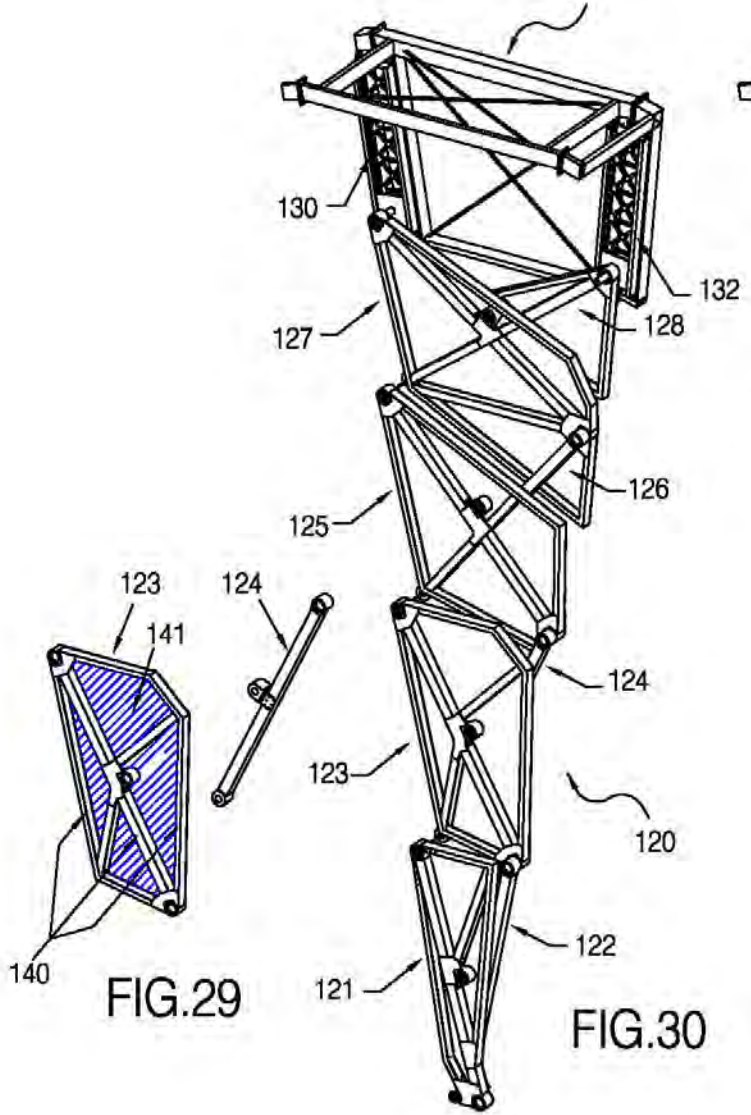


FIG.29

FIG.30

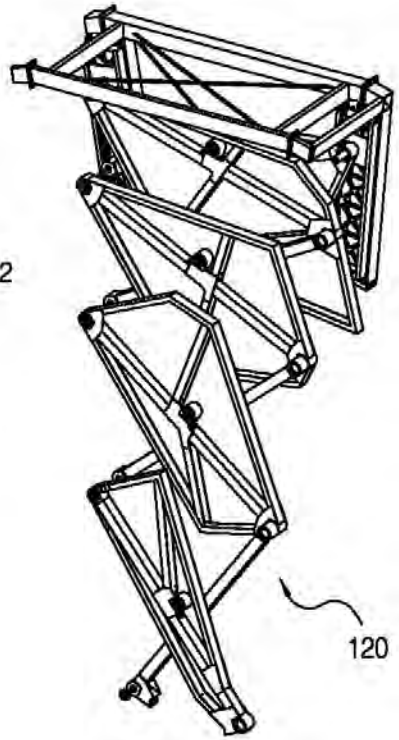


FIG.31

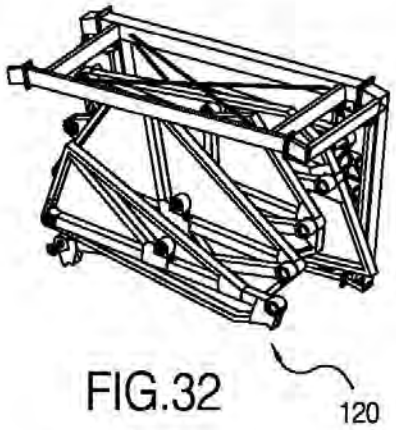


FIG.32

Structural approach

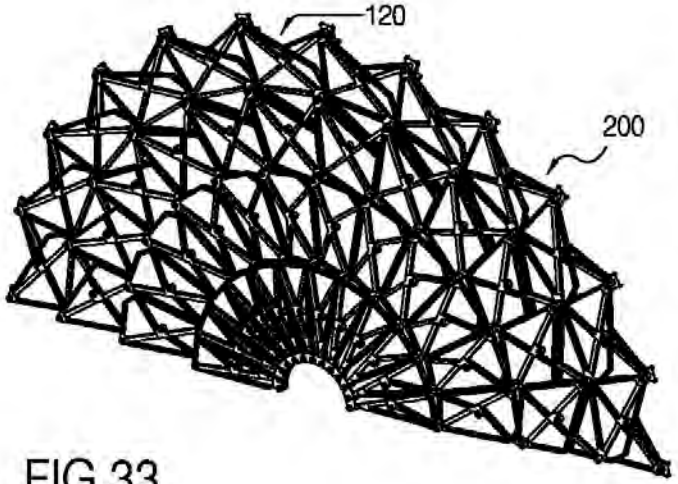


FIG.33

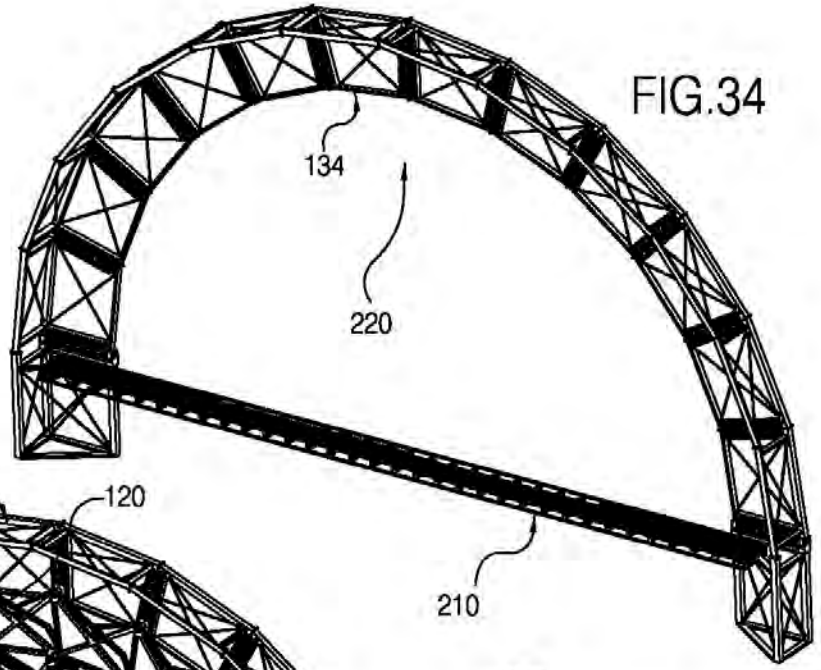


FIG.34

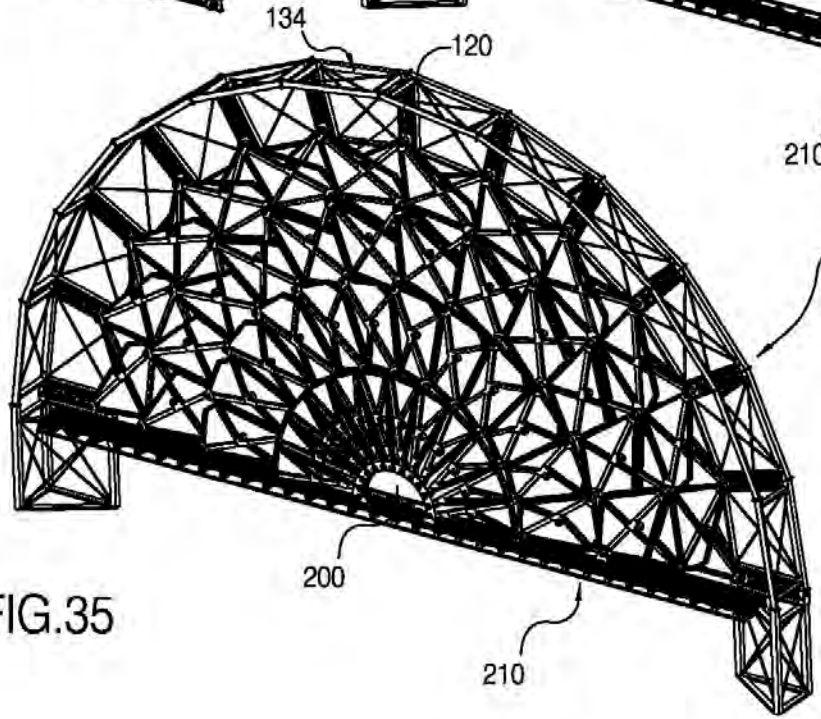


FIG.35

Iris structures

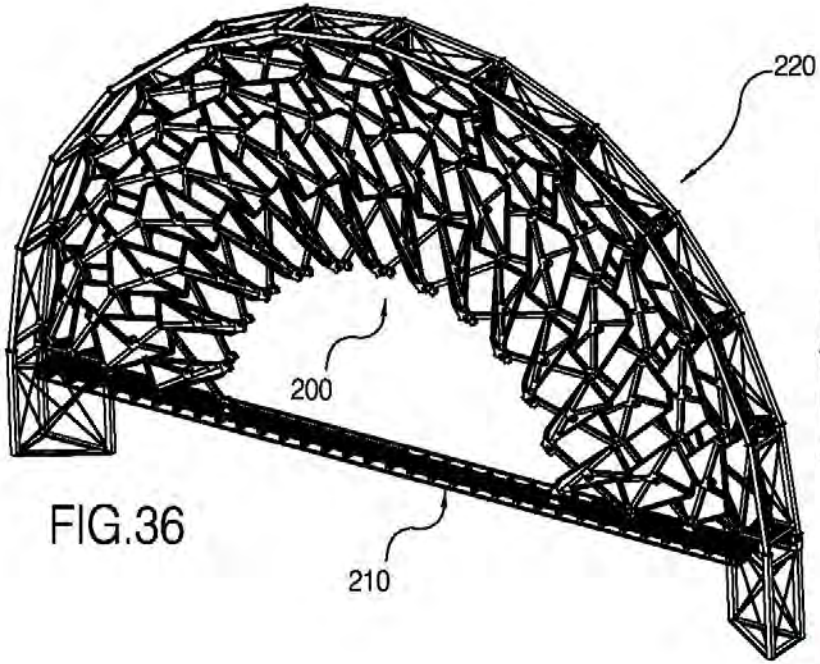


FIG.36

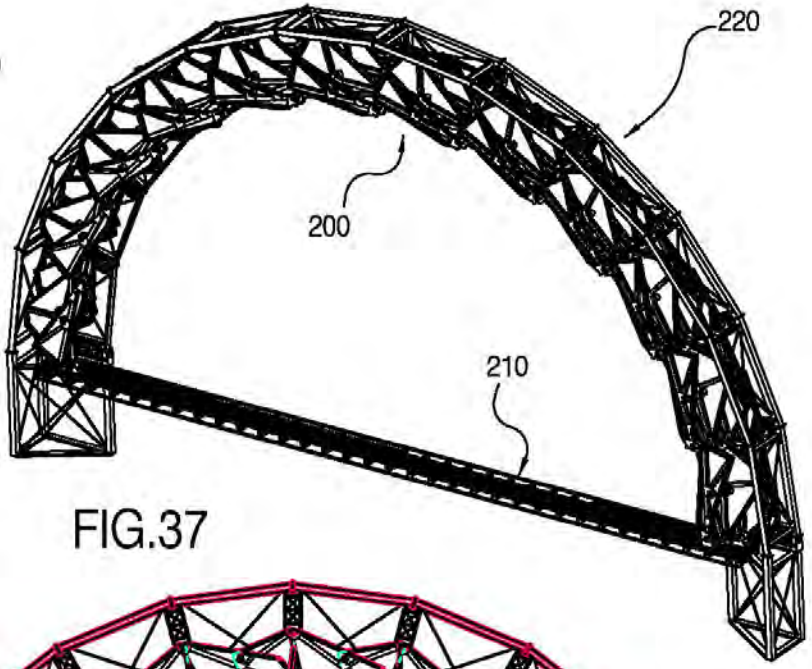


FIG.37

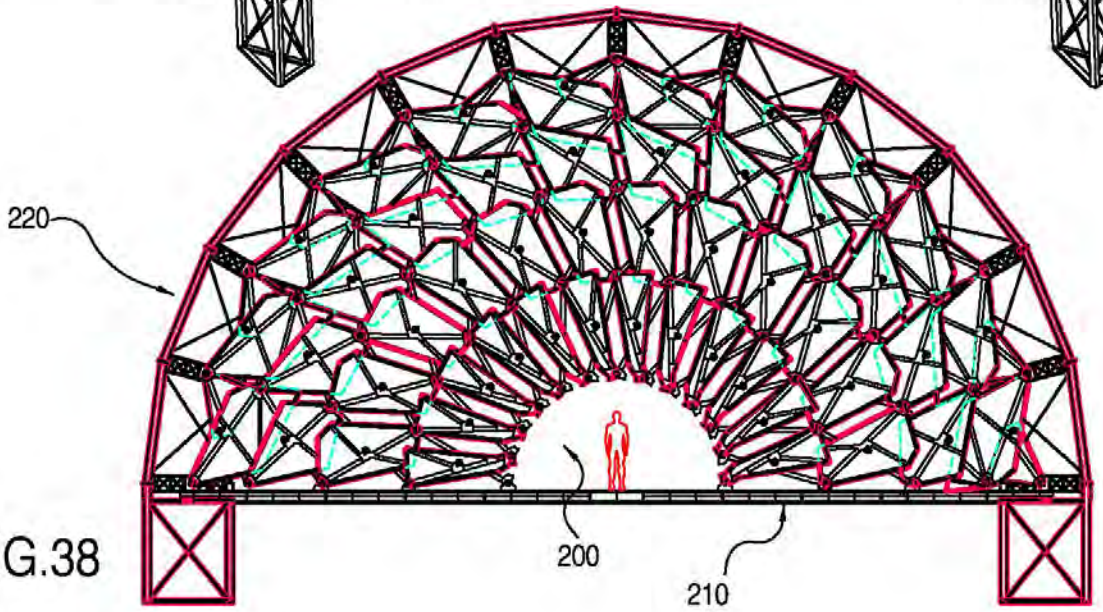


FIG.38

Olympic Arch, Salt Lake City 2002

Olympic Arch, Salt Lake City 2002

Olympic Arch

Olympic Arch

Olympic Arch

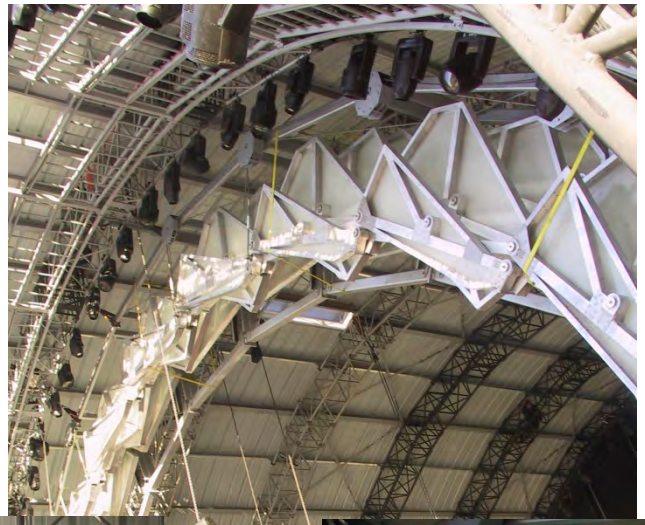
Olympic Arch

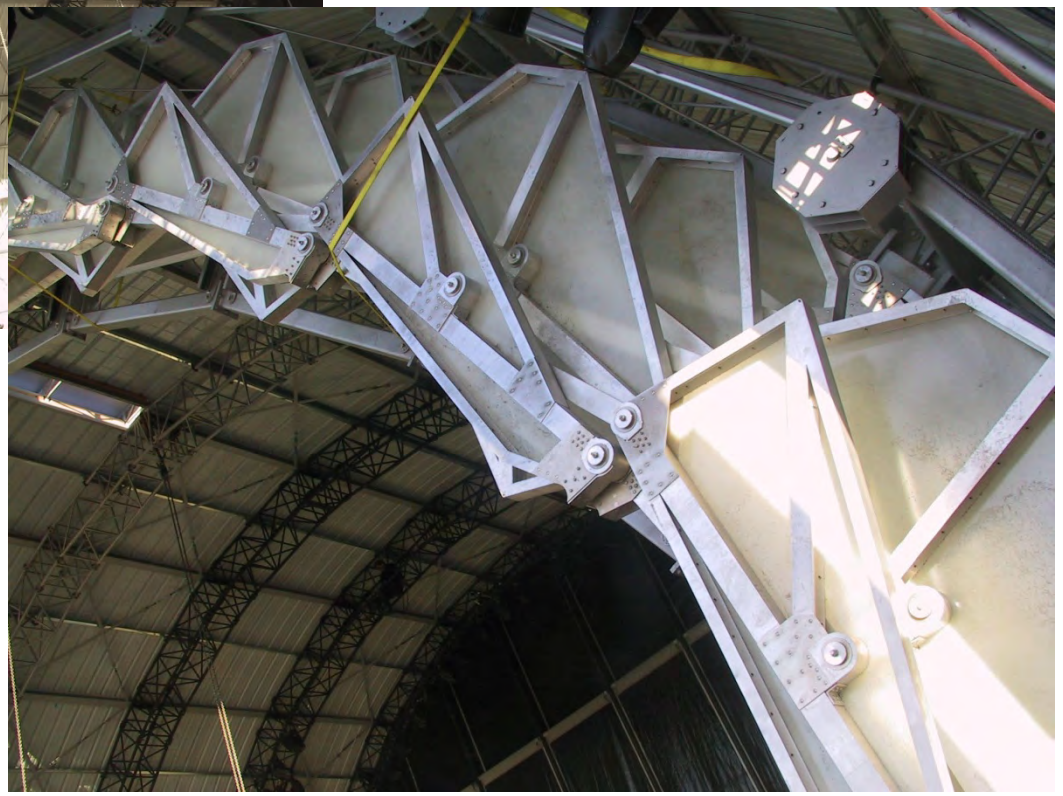
Olympic Arch

Olympic Arch

Olympic Arch

Olympic Arch





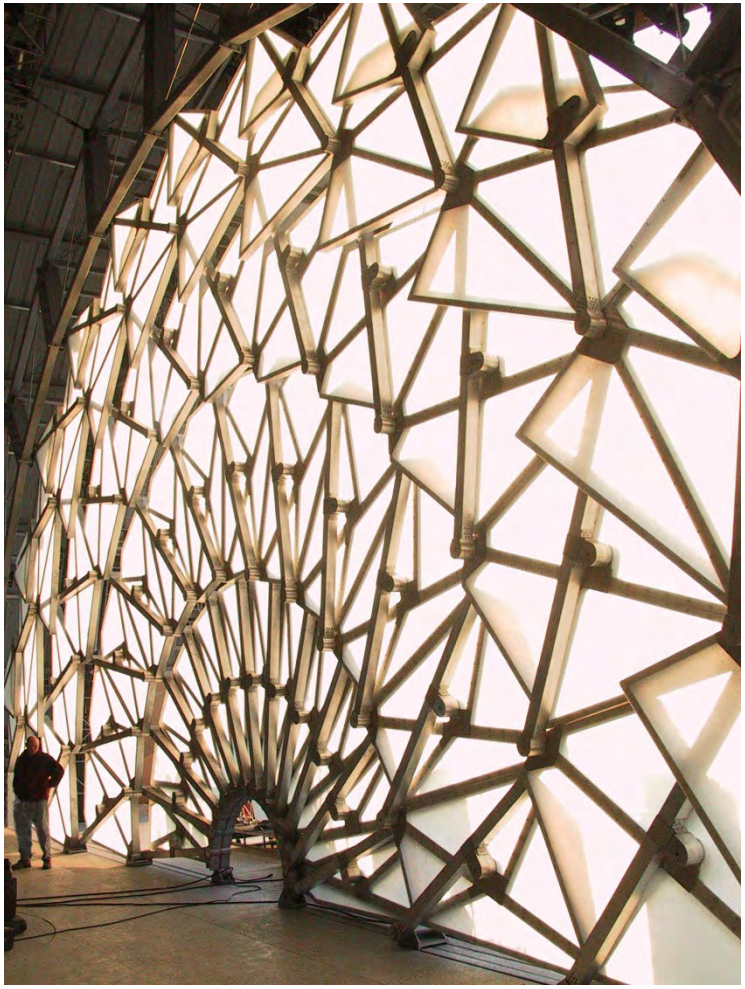
Olympic Arch

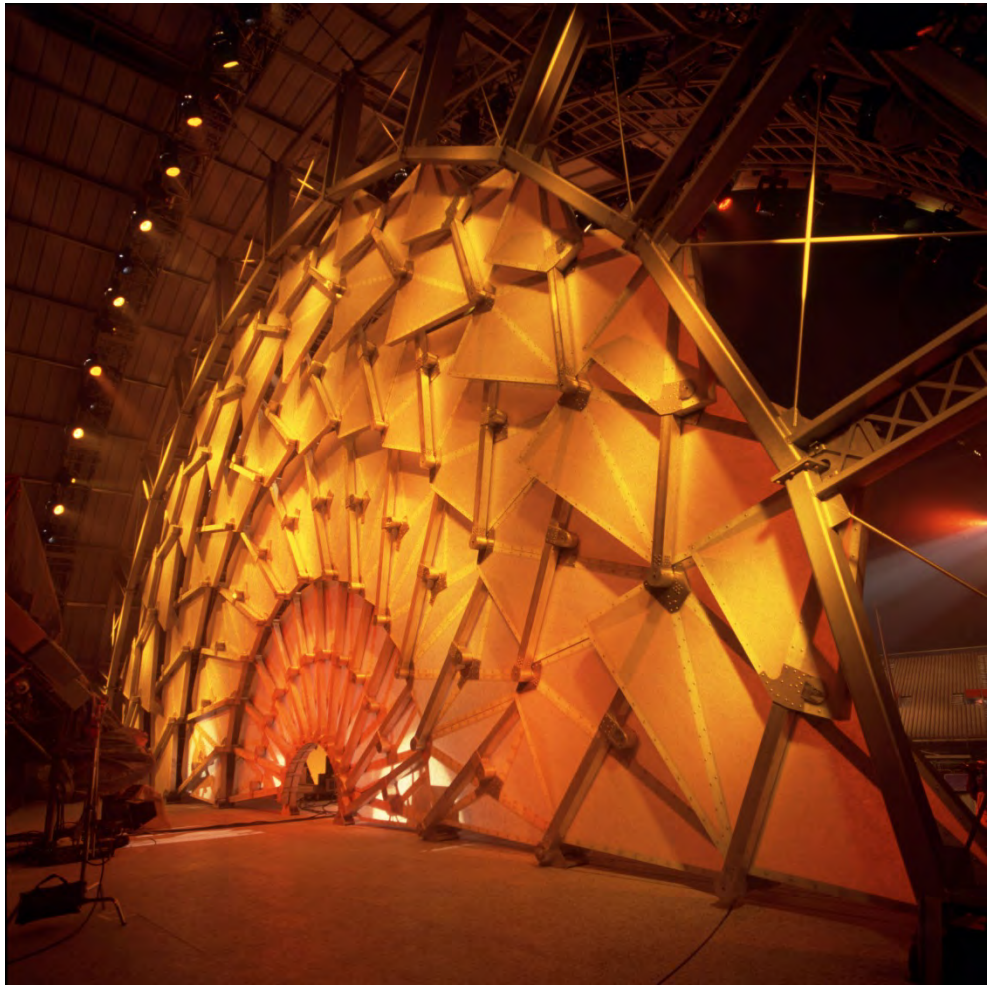
Olympic Arch

Olympic Arch

Olympic Arch, Salt Lake City 2002

Olympic Arch

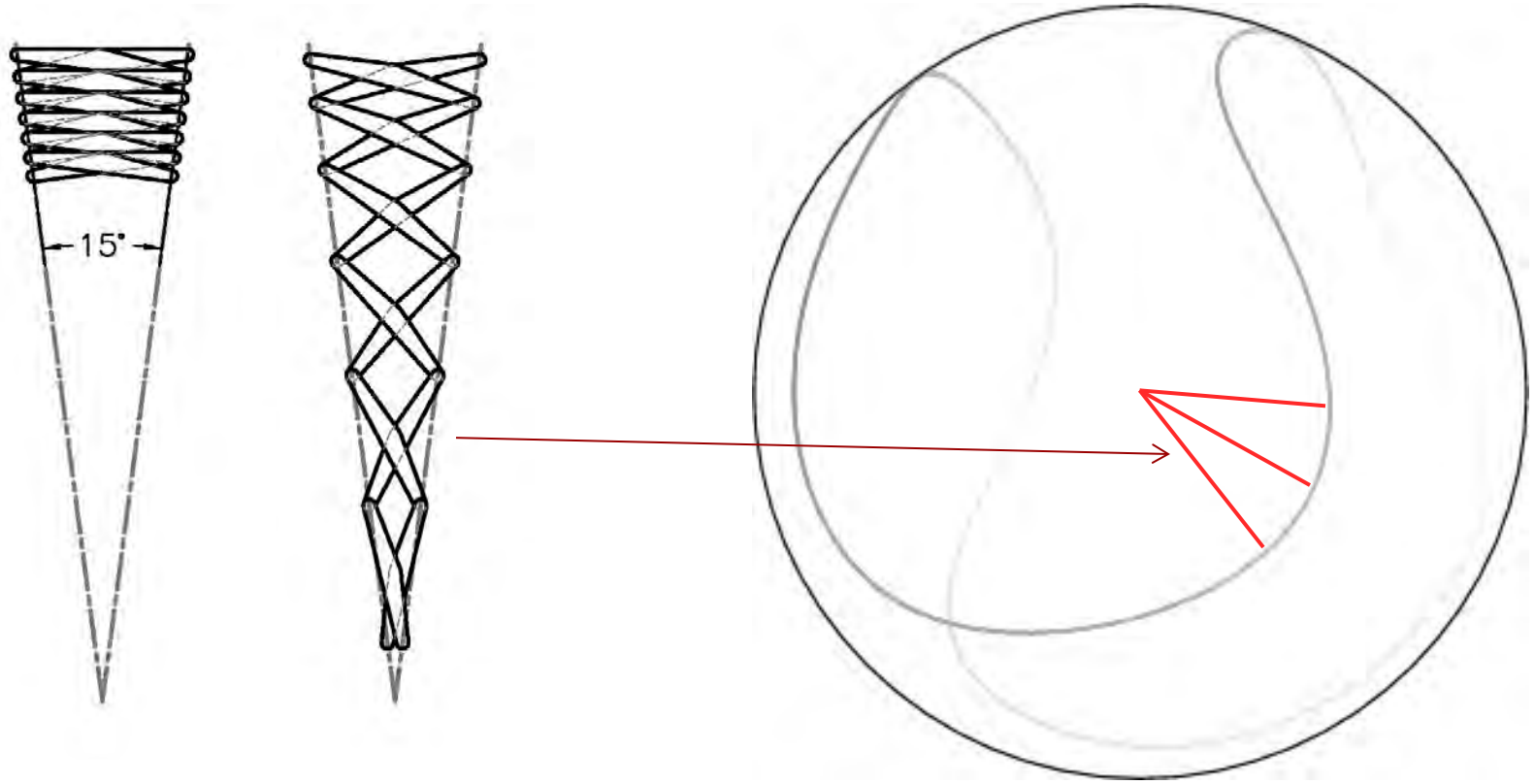




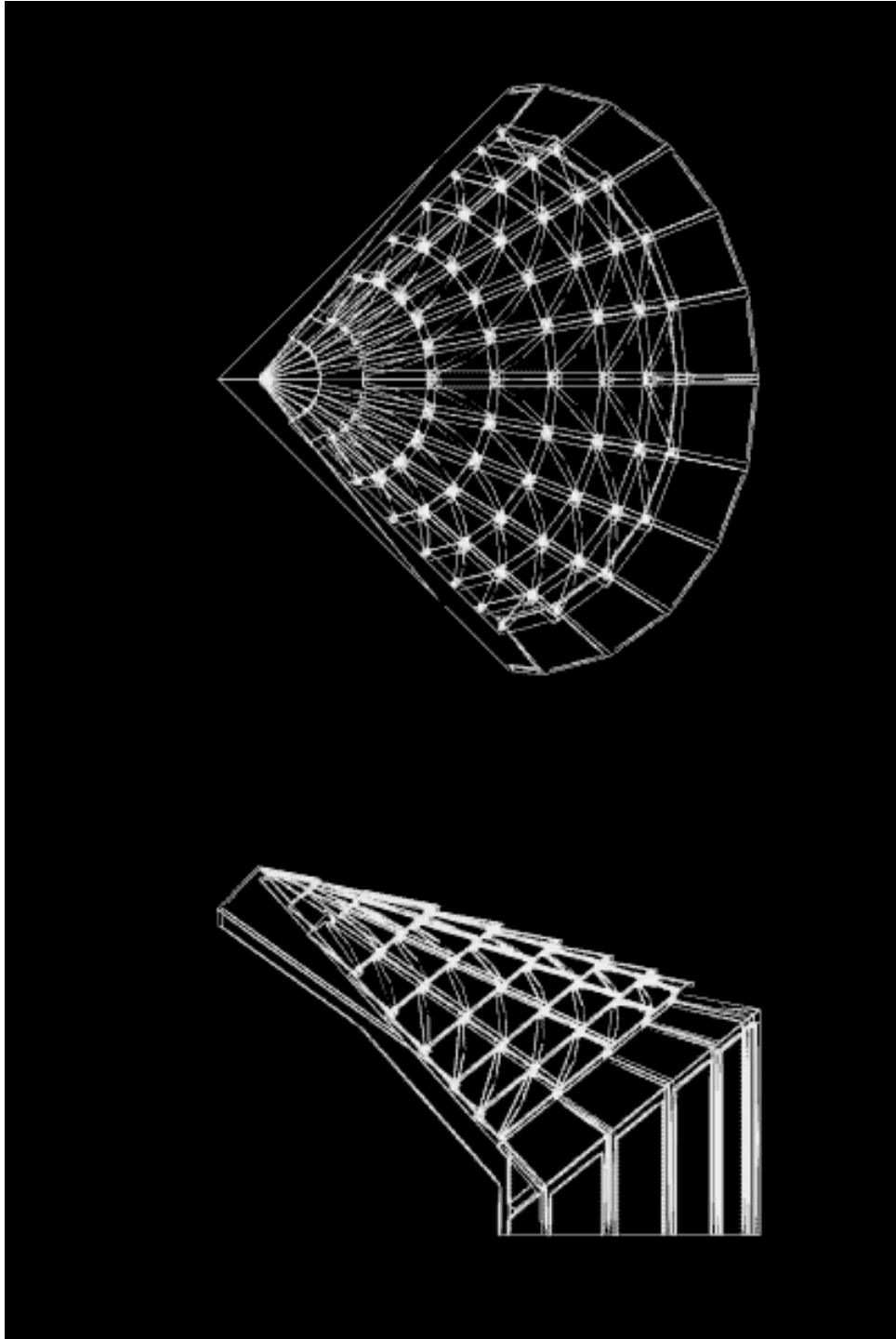
Olympic Arch, Salt Lake City 2002

Iris structures – defining by a curve on spherical surface

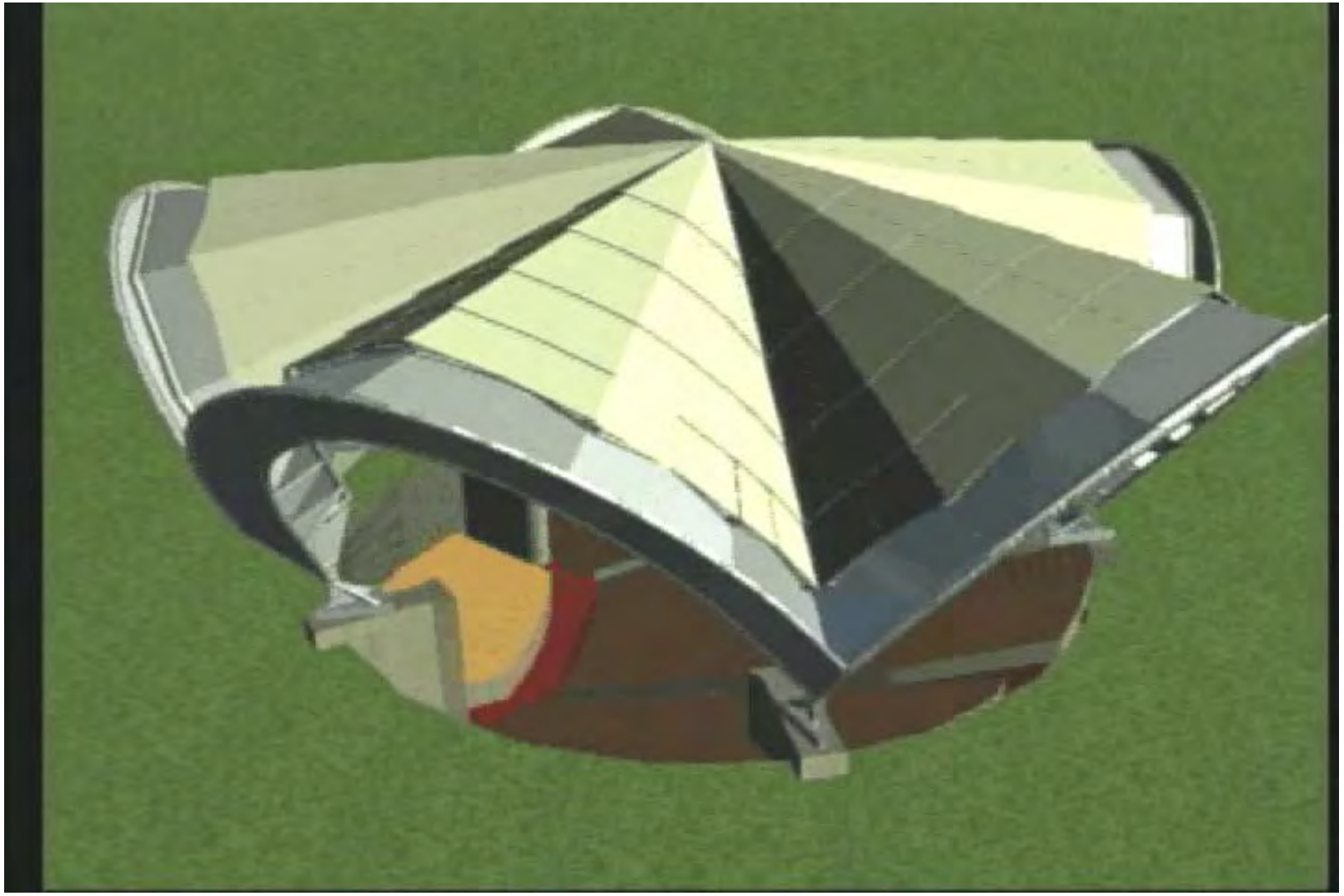
Tong linkage border is isosceles triangle – surfaces can be defined as shown



Iris (vaulted surface)



Iris (vaulted surface)



Iris (vaulted surface)

Iris - single curvature construction

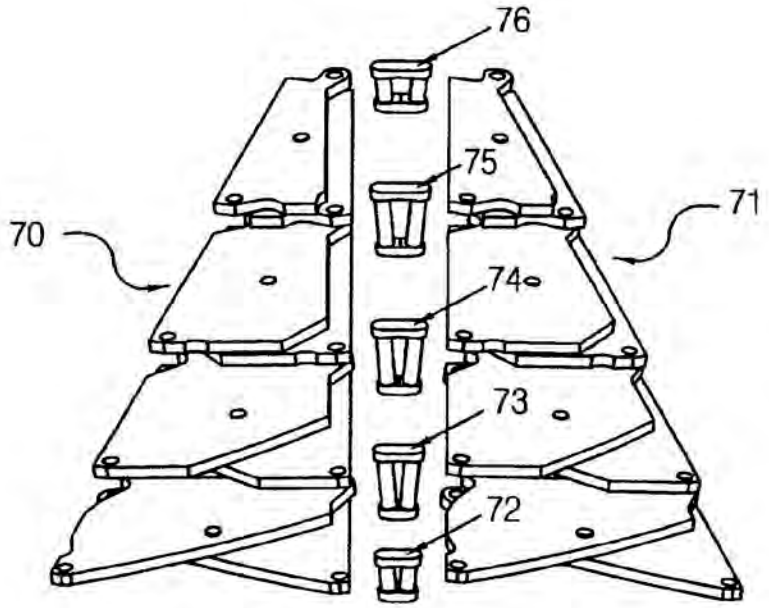


FIG.13

FIG.14

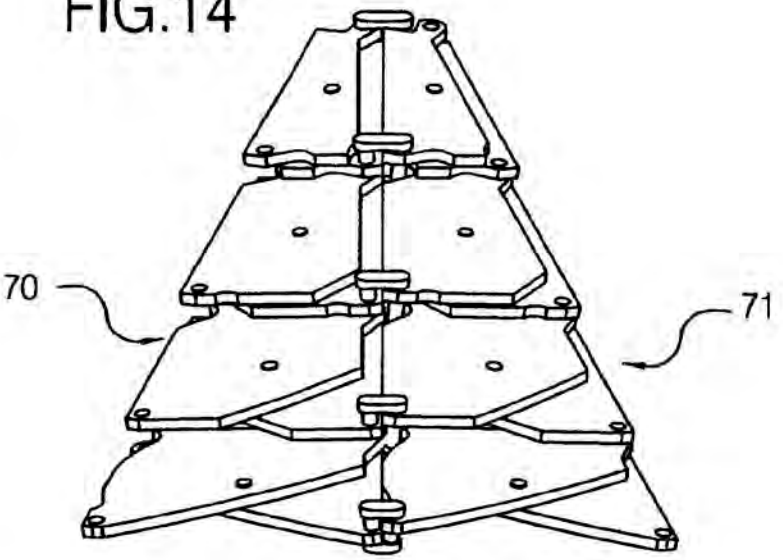


FIG.15

Iris - single curvature construction

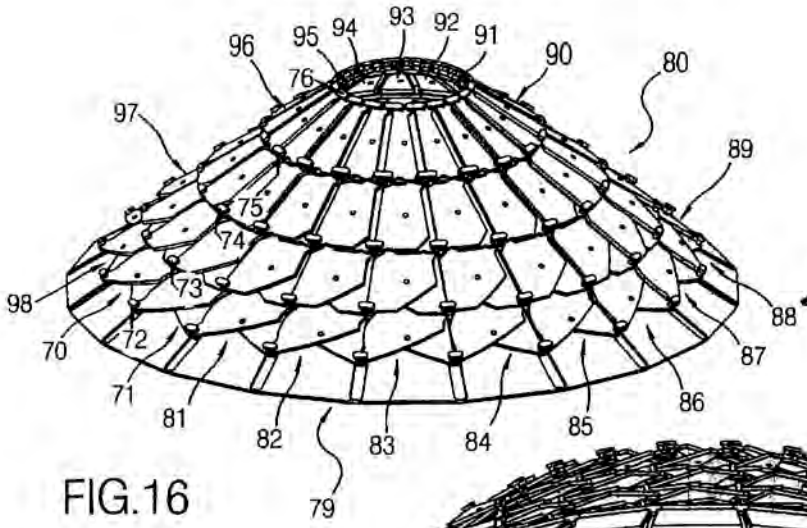


FIG.16

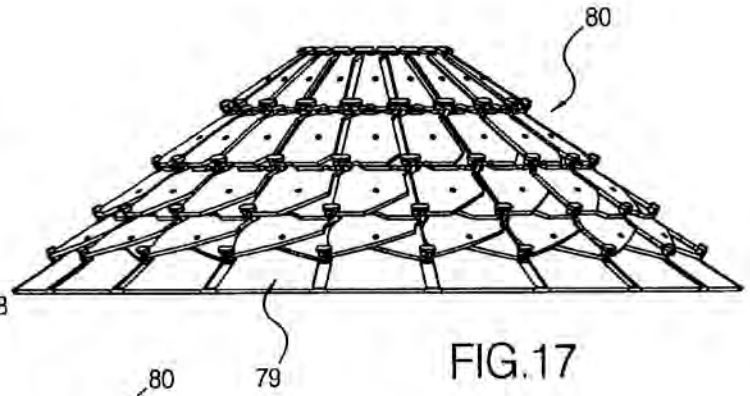


FIG.17

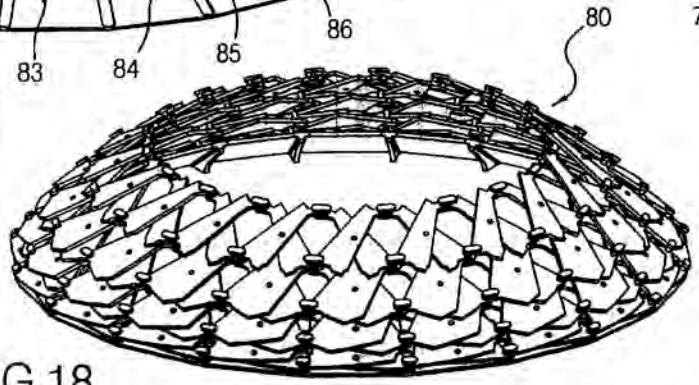


FIG.18

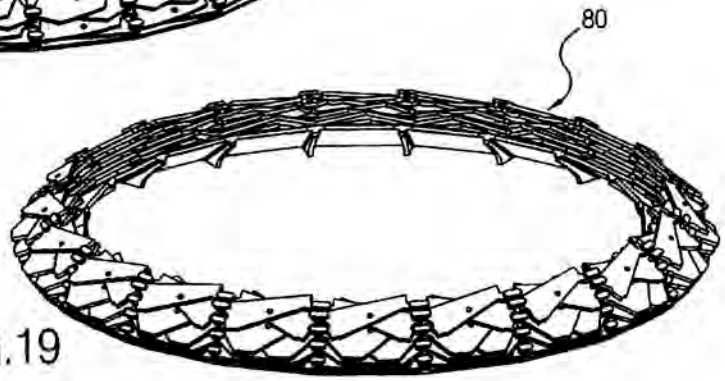
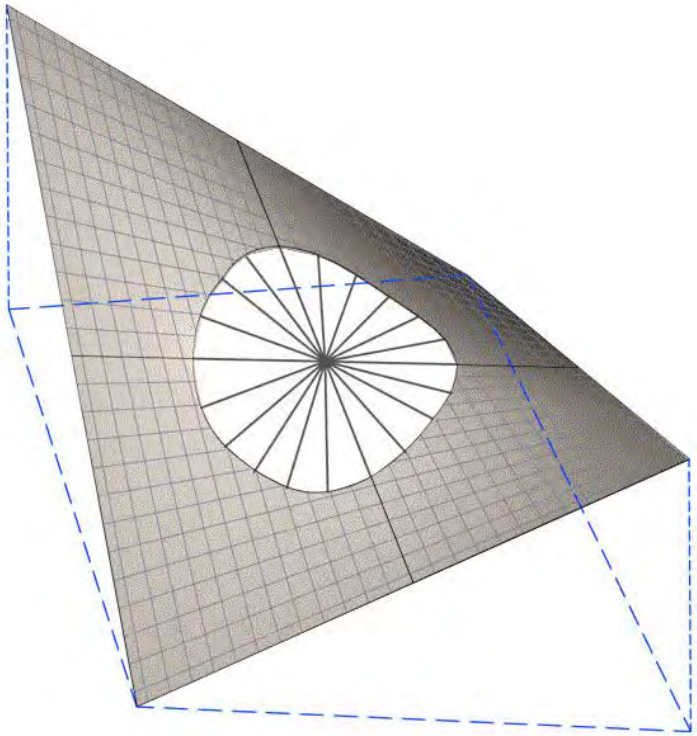
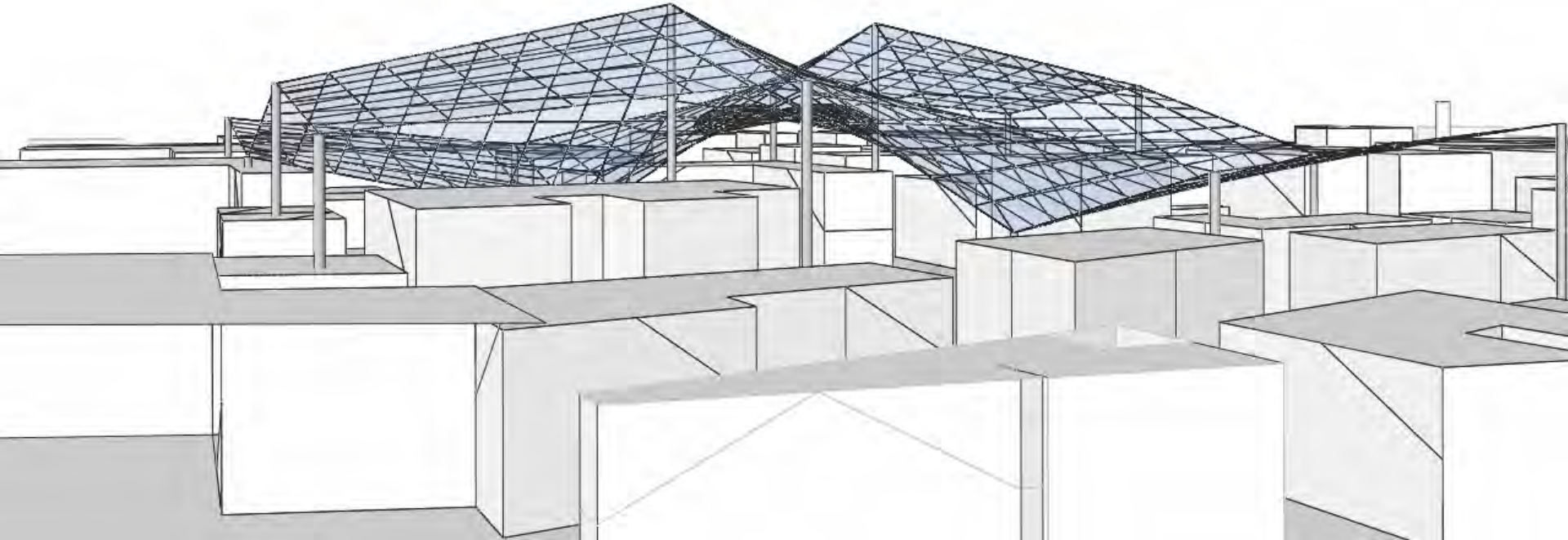


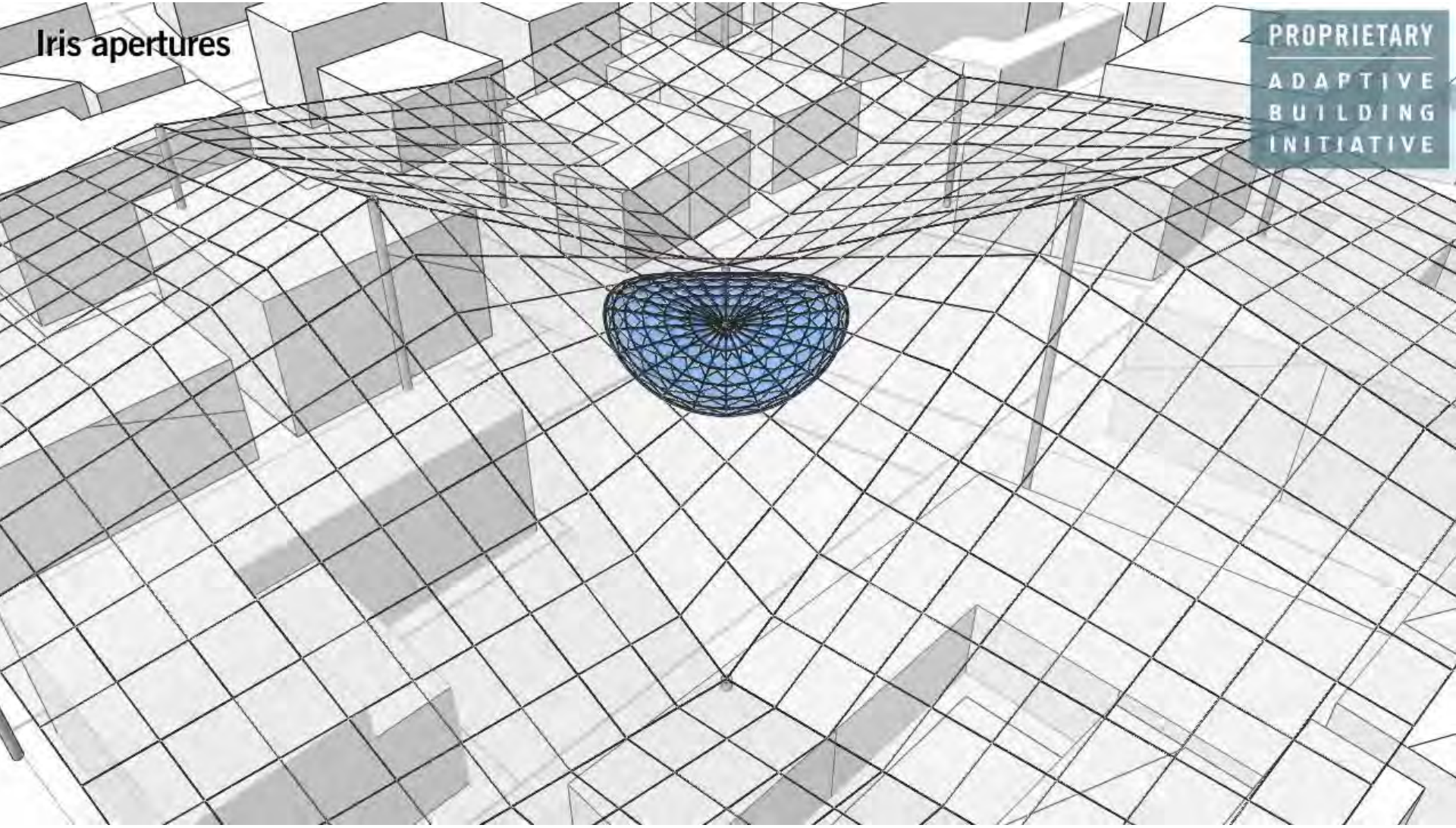
FIG.19

Iris (saddle surface)



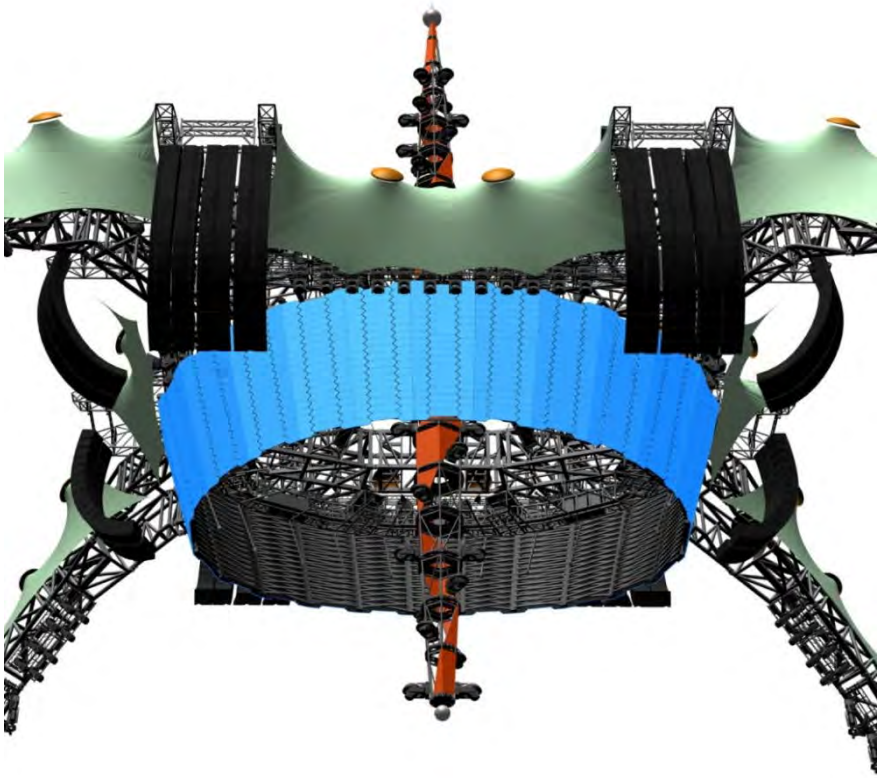


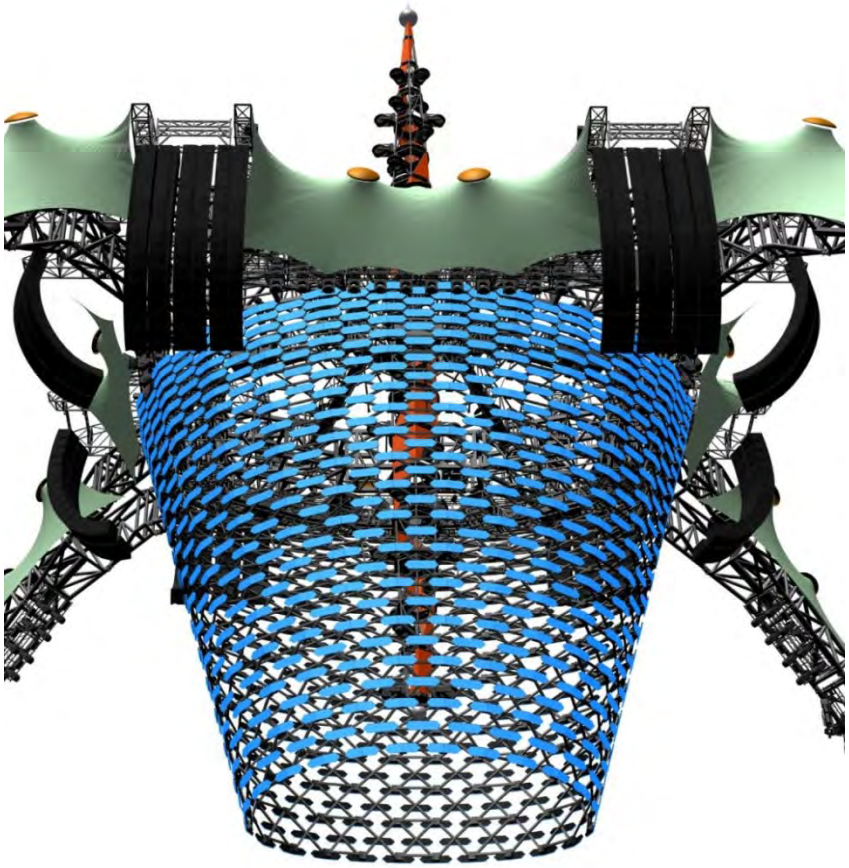
Iris (saddle surface)



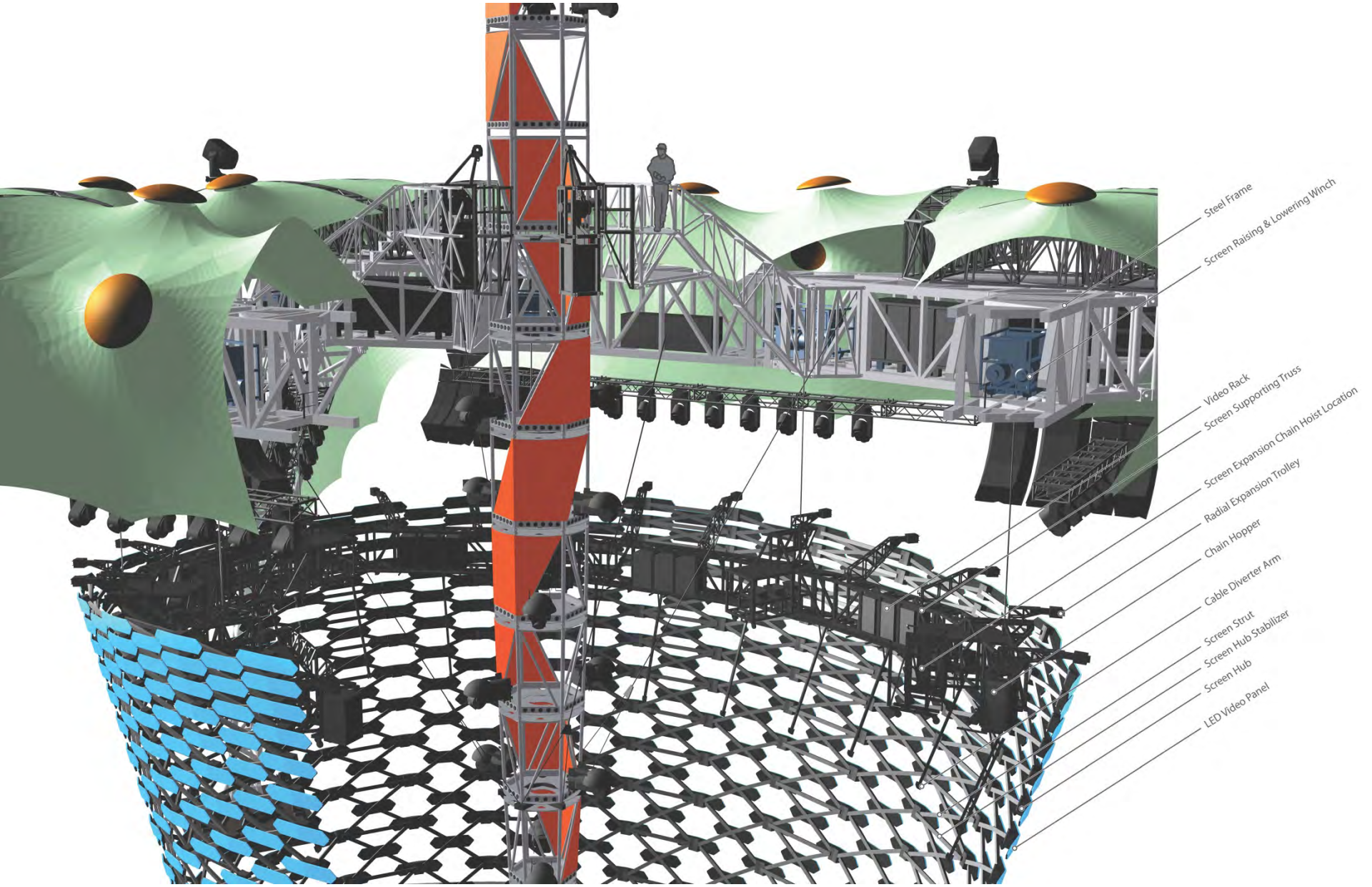
Iris - single curvature construction

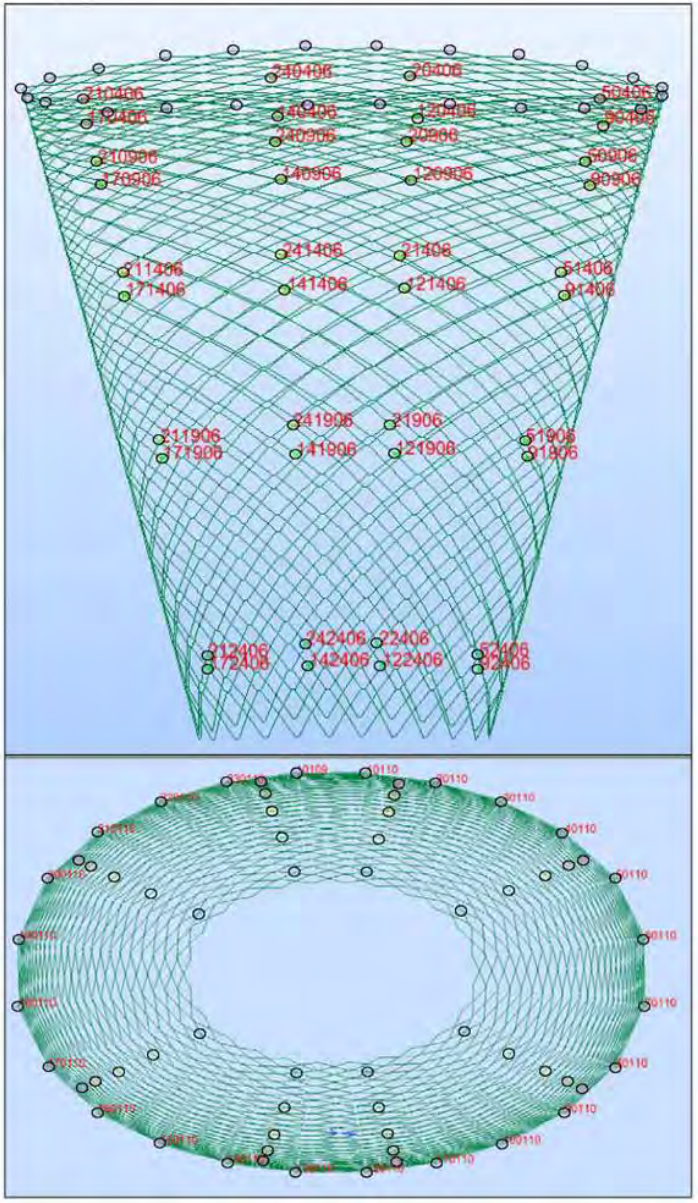
Scale





Scale


Steel Frame
Screen Raising & Lowering Winch
Video Rack
Screen Supporting Truss
Screen Expansion Chain Hoist Location
Radial Expansion Trolley
Chain Hopper
Cable Diverter Arm
Screen Strut
Screen Hub Stabilizer
Screen Hub
LED Video Panel

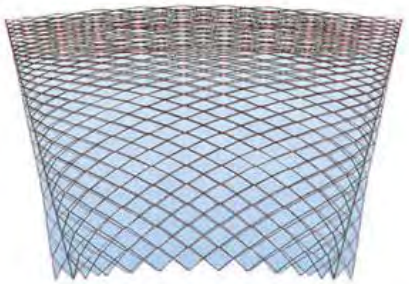


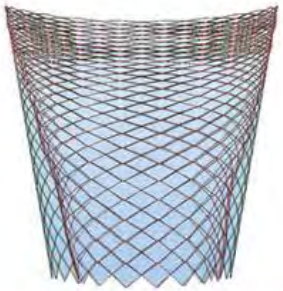
Node	Dead Load Only 0% FZ (lbs)	Dead Load Only 50% FZ (lbs)	Dead Load Only 100% FZ (lbs)	90 MPH Wind (Side) + DL 0% FZ (lbs)	90 MPH Wind (Side) + DL 50% FZ (lbs)	90 MPH Wind (Side) + DL 100% FZ (lbs)	90 MPH Wind (Front) + DL 0% FZ (lbs)	90 MPH Wind (Front) + DL 50% FZ (lbs)	90 MPH Wind (Front) + DL 100% FZ (lbs)
10109	364.26	416.61	452.2	145.48	170.27	253.48	513.95	636.92	499
10110	363.82	404.67	437.01	251.19	249.63	312.9	507.58	598.24	483.94
120110	362.91	416	453.13	219.48	237.26	333.02	959.62	996.68	849.81
130110	365.78	406.03	437.68	139.41	172.37	261.6	897.94	920.74	800.8
20110	221.83	239.4	266.06	192.12	177.4	224.84	328.19	365.76	306.3
110110	258.38	302.5	339.64	188.31	187.64	261.56	778.89	806.95	669.68
140110	224.31	241.03	266.69	-2.87	19.3	95.22	594.47	595.11	509
230110	260.79	303.61	338.49	5.78	40.07	147.25	389.55	491.99	381.61
30110	314.53	303.99	299.92	319.34	303.91	302.82	300.7	268.2	239.42
100110	246.31	254.94	277.8	230.78	222.36	256.57	514.73	518.76	476.68
150110	315.38	304.53	300.3	211.09	205.7	221.27	469.76	462.84	435.68
220110	248.86	256.79	278.4	90.76	99.27	159.89	277.94	290.4	252.01
40110	528.58	503.56	444.5	545.82	534.91	464.85	373.83	291.36	241.04
90110	450.08	420.64	374.33	476.35	454.89	389.9	417.93	416.23	417.82
160110	528	503.07	444.02	591.26	574.68	516.34	476.13	482	469.32
210110	449.58	420.27	374.41	476.98	458.58	412.19	320.24	238.12	210.58
50110	275.19	279.48	274.19	274.39	285.28	280.38	168.68	143	126.68
80110	389.28	372.22	325.89	405.72	393.83	324.85	309.88	334.13	349.91
170110	274.65	279.02	273.59	326.72	328.71	317.99	264	300.48	319.18
200110	388.59	371.79	326	473.53	462.44	399.89	244.78	184.6	160.47
60110	-3.63	17.88	60.16	-15.37	5.18	57.35	-21.75	2.47	31.01
70110	53.46	66.72	94.28	46.98	59.3	88.51	54.92	88.86	124.25
180110	-3.92	17.65	59.93	3.52	14.83	45.92	22.15	61.76	99.55
190110	53.15	66.5	94.23	77.32	83.42	98.05	14.2	25.39	49.43
20406	1616.92	1730.12	1977.99	1265.7	1205.28	1253.65	2014.63	2216.38	1977.27
120406	1550.55	1745.57	2045.97	1061.9	1050.27	1167.53	3475.99	3708.26	3848.37
140406	1627.48	1737.33	1981.21	1027.34	1179.82	1679.57	3126.22	3250.83	3427.71
240406	1561.66	1752.61	2045.02	897.63	1057.82	1575.05	2052.91	2484.15	2193.36
50406	2382.43	2252.21	1936.05	2561.44	2524.86	2085.56	1440.44	1003.87	815.95
90406	2449.41	2280.85	1936.62	2679.25	2560.73	1973.64	859.08	814.35	841.02
170406	2378.74	2249.09	1931.2	3364.56	3356.75	3194.78	852.92	809.39	762.57
210406	2448.26	2281.35	1942.15	3386.1	3365.95	3154.34	1556.72	1080.82	974.99
20906	1869.55	2016.44	2638.18	1403.12	1206.11	1270.45	2362.93	2757.72	2585.56
120906	1835.91	2036.59	2671.4	1328.29	1149.59	1173.69	3393.4	3855.39	4787.69
140906	1881.82	2026.4	2644.76	1358.96	1435.57	2384.42	3311.67	3671.36	4587.48
240906	1837.29	2034.1	2658.98	1365.32	1426.46	2295.63	2284.18	2873.68	2746.41
50906	2928.7	2711.23	2127.31	3116.35	3053.63	2153.15	1858.38	1033.95	176.83
90906	2952.26	2718.11	2133.06	3159.12	3018.42	1935.08	1744.13	1404	1446.01
170906	2924.9	2707.27	2120.92	3908.03	3984.86	4020.6	1631.18	1243.21	1109.76
210906	2949.23	2715.96	2136.93	3809.21	3870.85	3806.12	2011.36	1217.55	532.19
21406	1675.92	2020.13	2776.2	1292.82	943.53	1556.19	2106.32	2917.7	1694.52
121406	1699.57	2060.17	2760.08	1326.48	945.38	1367.63	2575.41	3922.62	4141.75
141406	1704.08	2047.34	2796.91	1396.9	1594.26	3206.33	2611.69	3894.43	4041.41
241406	1651.02	2011.92	2699.35	1471.2	1628.62	3005.73	1937.65	2928.07	1820.49
51406	2786.78	2439.81	1658.47	2915.28	2834.3	1152.69	1970.16	215.58	-402.43
91406	2782.41	2429.8	1625.07	2941.58	2792.15	918.41	2111.93	1372.71	2570.95
171406	2784.89	2436.67	1651.81	3497.74	3944.49	3745.7	2024.07	1141.15	2159.87
211406	2773.95	2421.47	1623.94	3338.57	3725.45	3377.82	2082.41	428.9	-55.96
21906	1833.52	2172.62	2769.89	1520.14	825.24	1628.67	2133.38	3211.26	1511.49
121906	1875.27	2180.15	2691.39	1592.49	778.57	1295.99	2057.47	3102.85	2051.92
141906	1837.98	2198.85	2788.66	1649.71	1755.72	3081.25	2058.18	3114.25	1902.18
241906	1844.25	2153.73	2649.41	1799.67	1802.59	2823.18	1945.56	3154.87	1607.32
51906	2921.75	2361.81	1794.11	2985.72	2542.94	269.64	2309.32	-150.72	916.93
91906	2877.82	2333.88	1713.4	2991.34	2528.89	56.54	2520.14	1687.6	4378.02
171906	2906.67	2344.43	1778.53	3330.55	3475.31	2445.67	2484.74	1494.29	4146.66
211906	2868.94	2323.41	1709.75	3132.51	3222.74	2072.45	2372.55	44.91	1196.86
22406	1262.79	1785.11	2083.1	1139.32	1449.58	3023.2	1413.91	1904.5	-1096.8
122406	1246.61	1701.98	1934.71	1146.02	1295.16	2641.42	1377.16	2344.06	1041.25
142406	1197.77	1724.48	2014.72	1194.82	1853.96	3346.35	1354.45	2247.35	825.43
242406	1142.27	1609.74	1833.7	1224.3	1770.27	3012.35	1174.79	1684.46	-1101.15
52406	2132.85	1865.13	1740.09	2163.87	1813.13	418.64	1936.41	705.86	1555.15
92406	2042.51	1752.64	1551.66	2100.13	1719.2	112.28	2237.47	3558.95	7222.95
172406	2085.9	1811.32	1684.62	2361.19	2945.33	3320.34	2244.84	3463.71	6931.34
212406	2035.42	1745.53	1546.04	2217.41	2721.21	2867.88	1901.83	760.96	1719.7

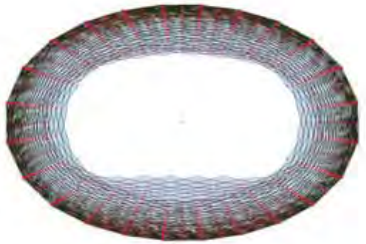
Support Case 2

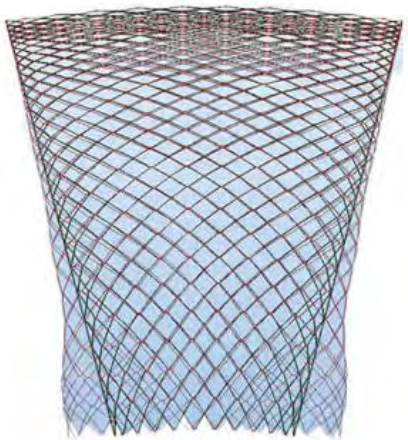
Cable Loads

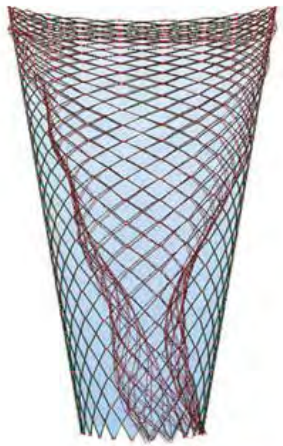
HOBERMAN

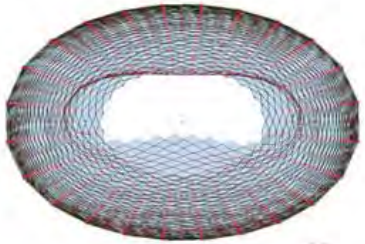










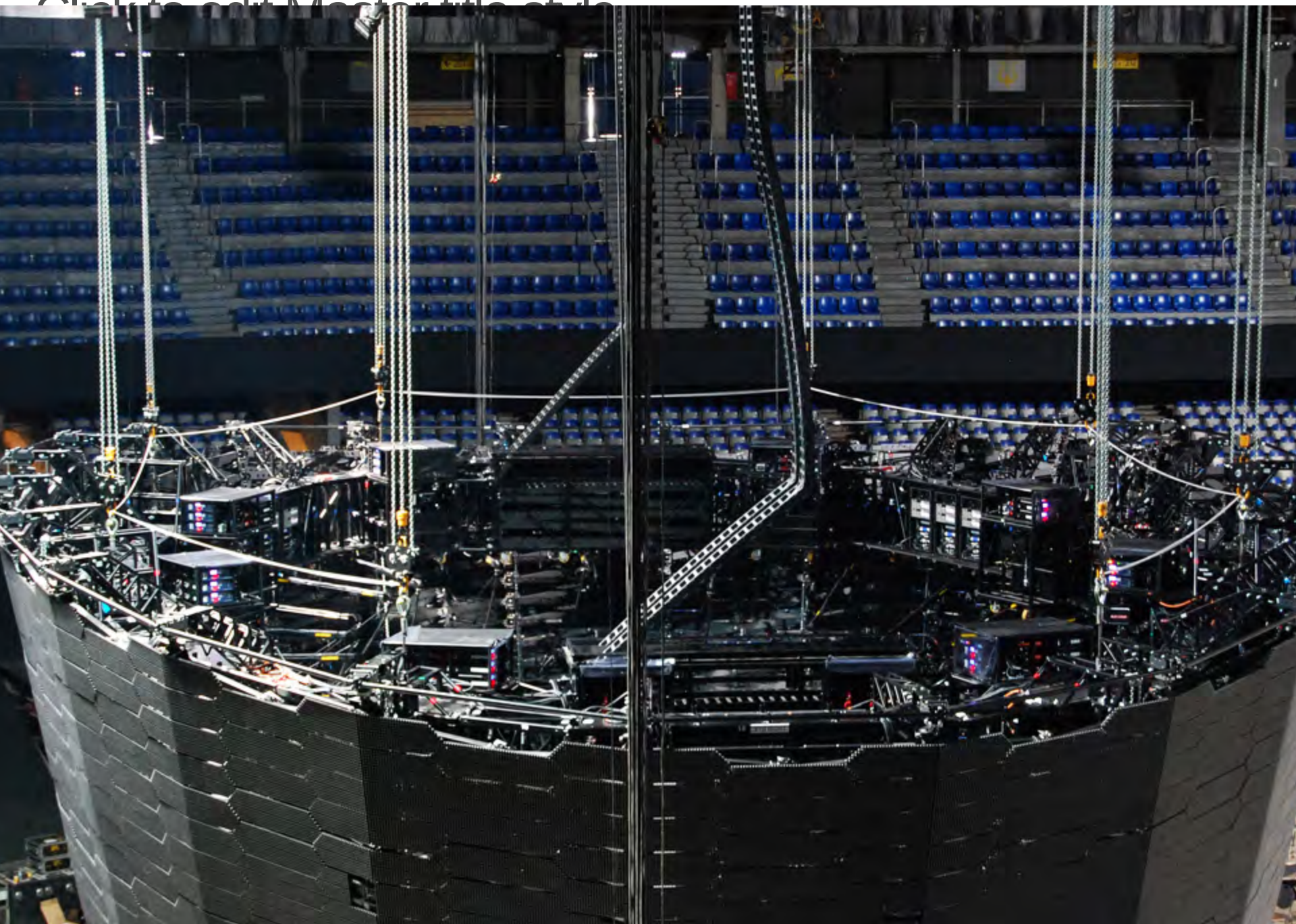


HOBERMAN

Right & Front Wind Loading (90 MPH)

U2 360 Tour


D3
D4
D5



Iris - double curvature construction

FIG.20

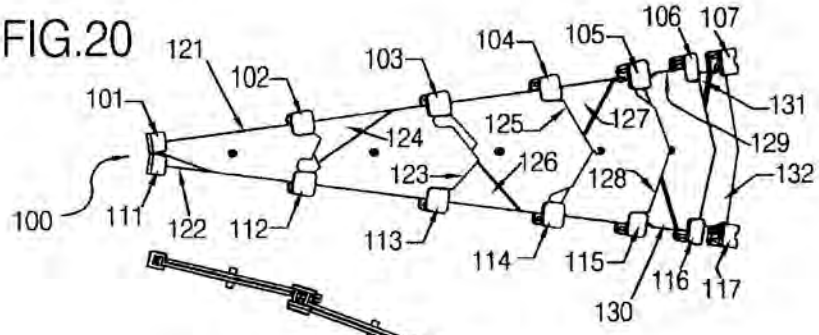


FIG.21

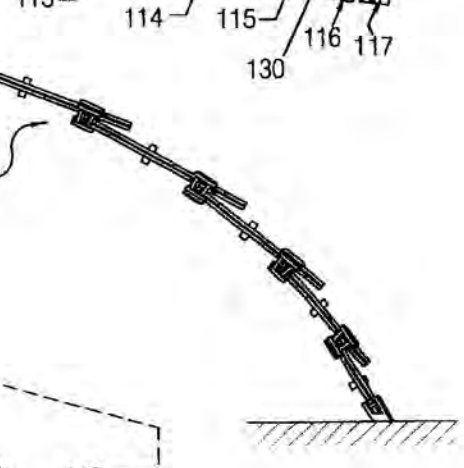
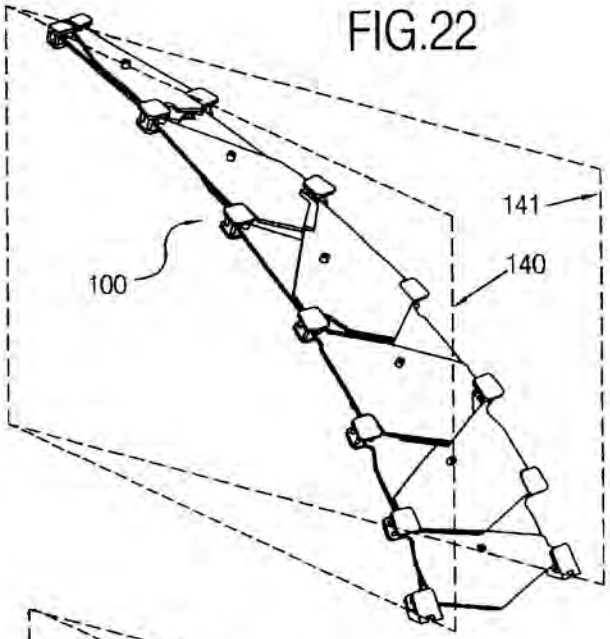


FIG.22



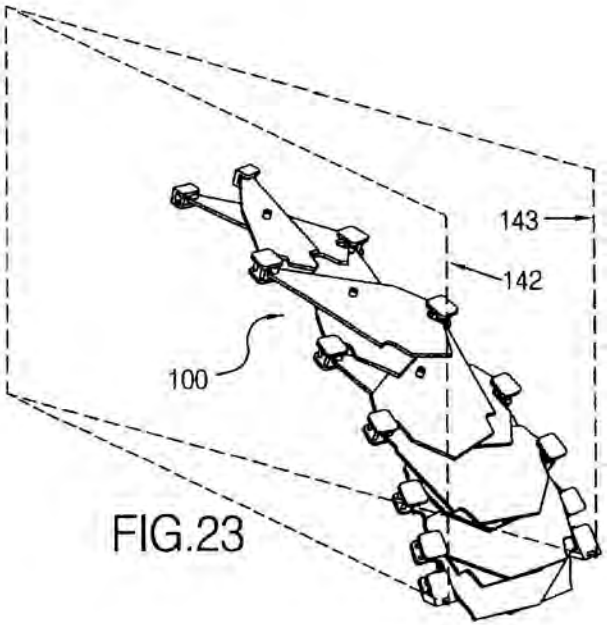


FIG.23

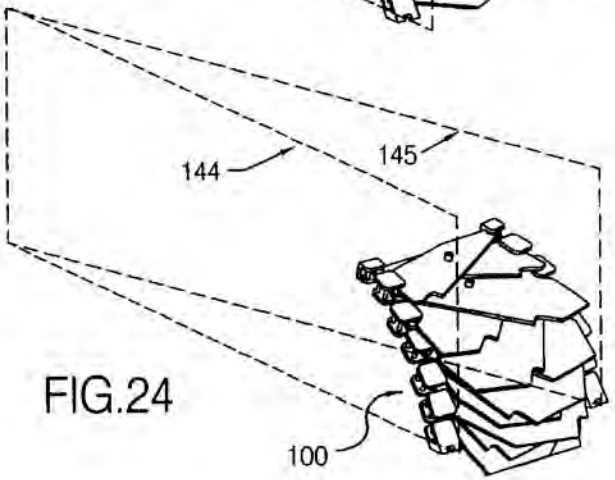
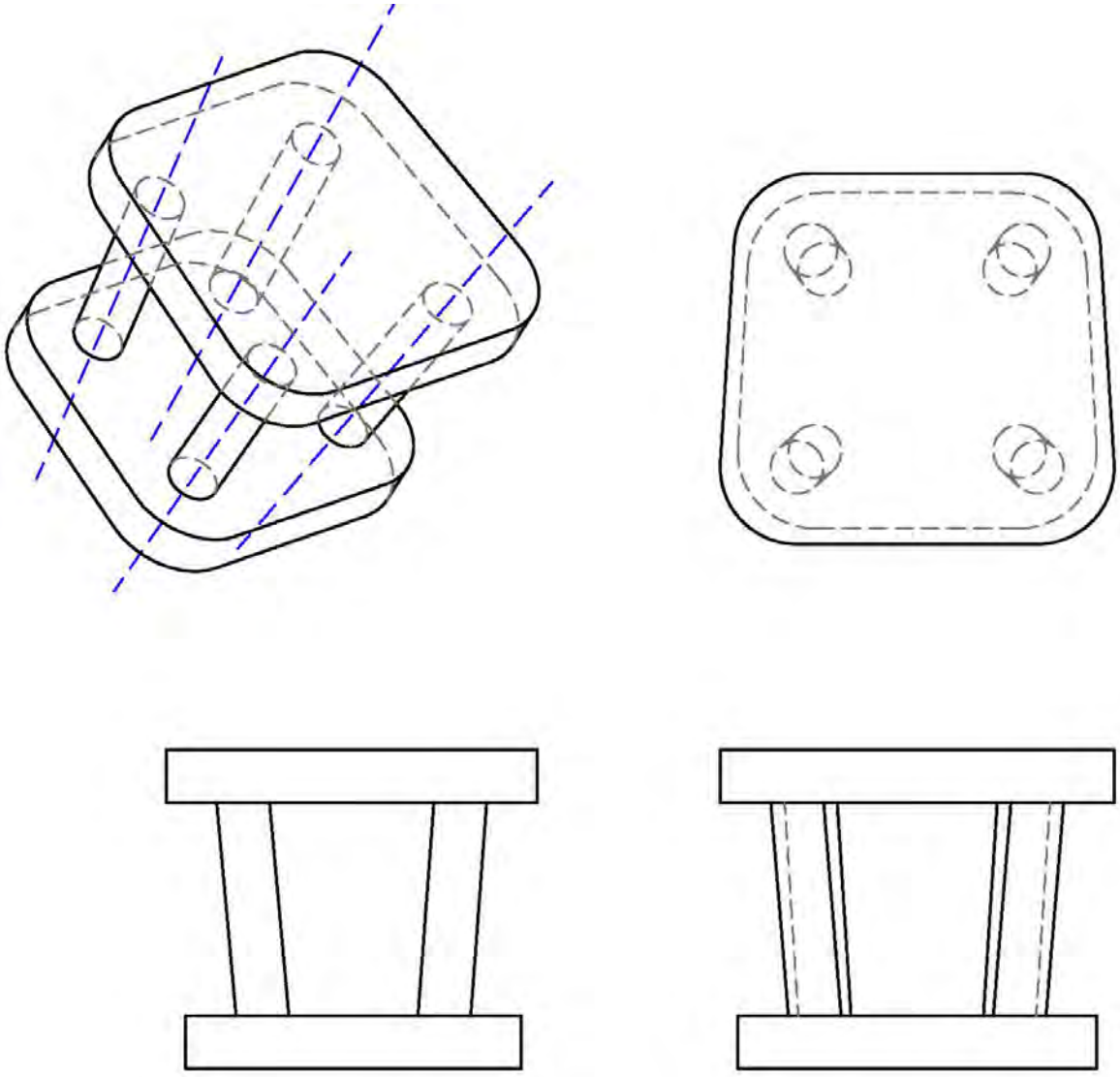


FIG.24

Iris - double curvature construction



Iris - single curvature construction

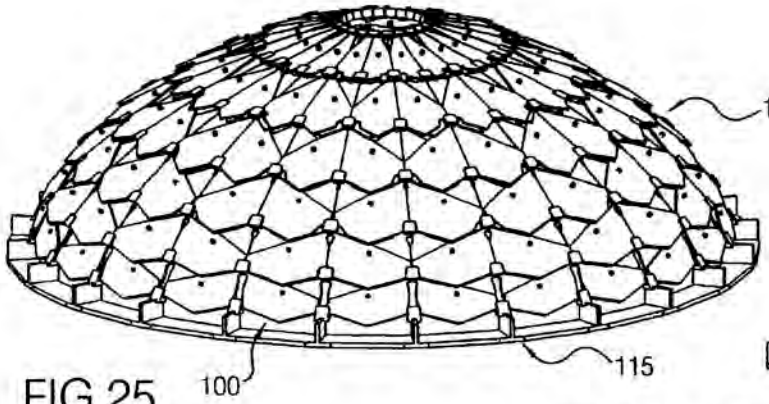


FIG.25

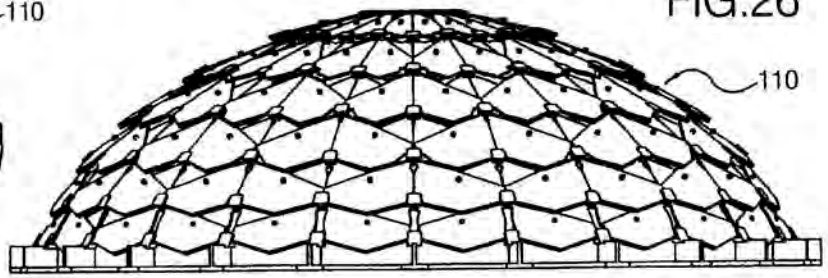


FIG.26

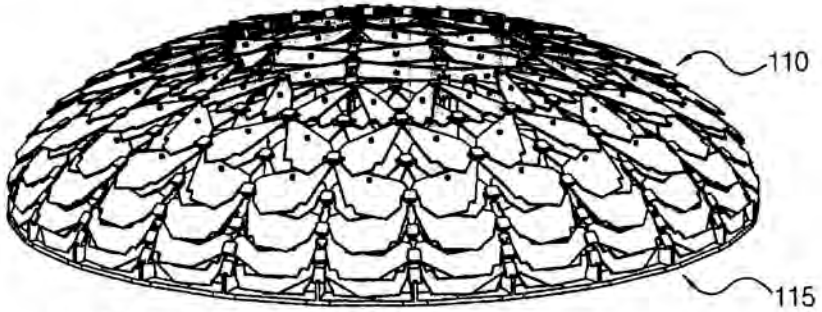


FIG.27

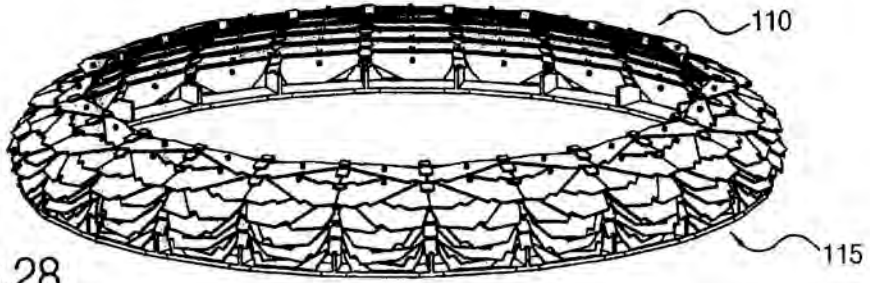
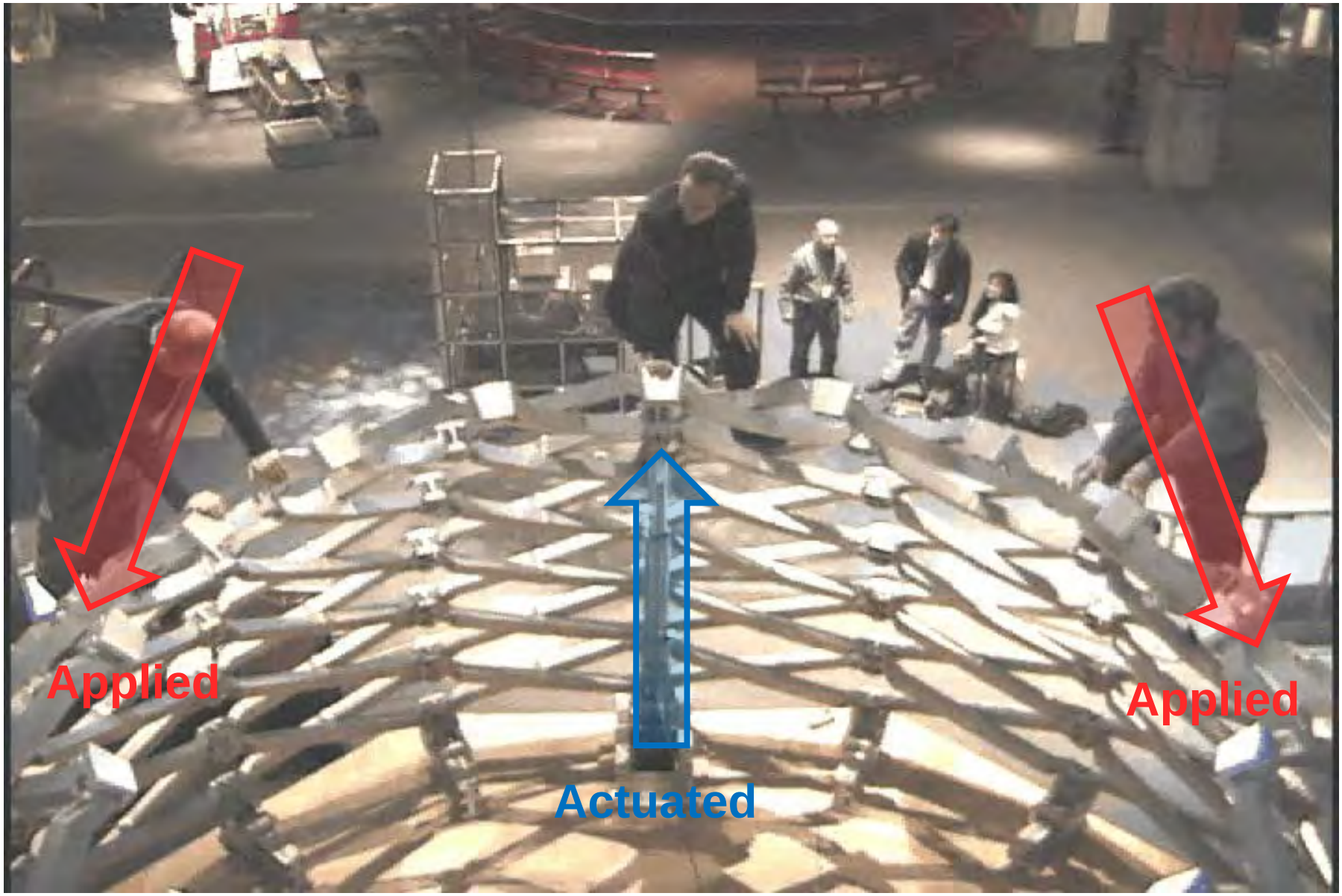


FIG.28

Expo 2000, Hannover

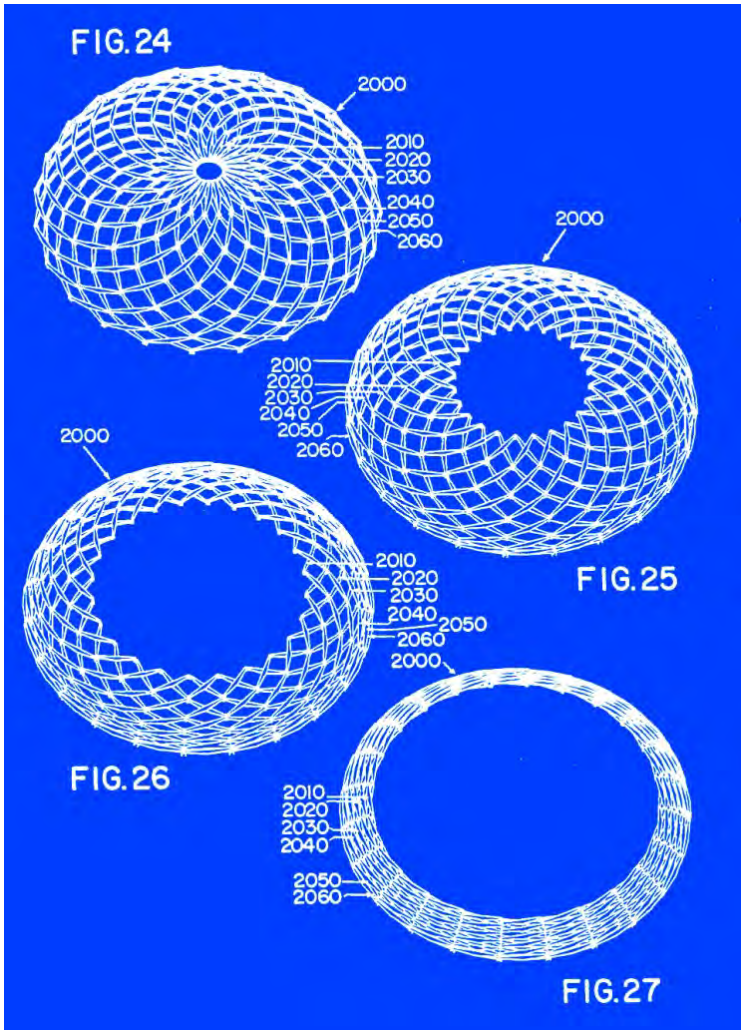
Resolving forces between kinematic and structural modes

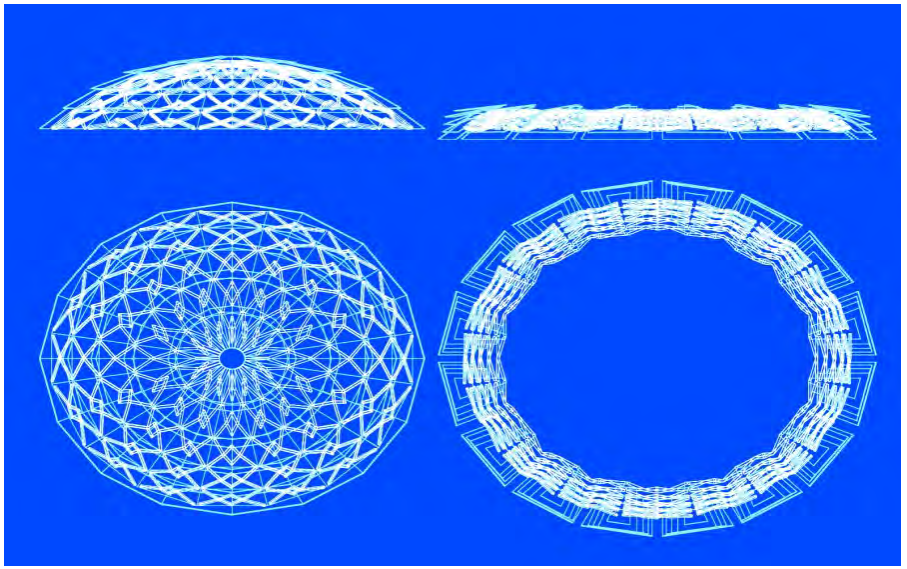


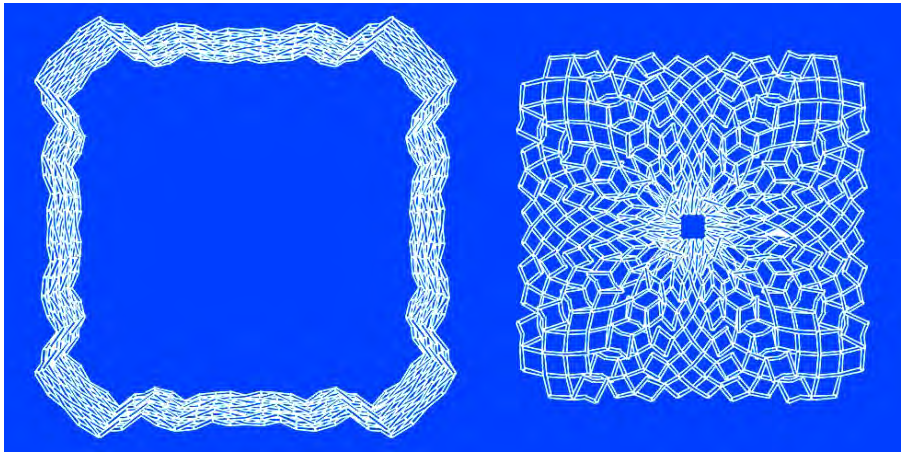
Stability defined as a process, not a state

Iris - hub construction

Iris structures

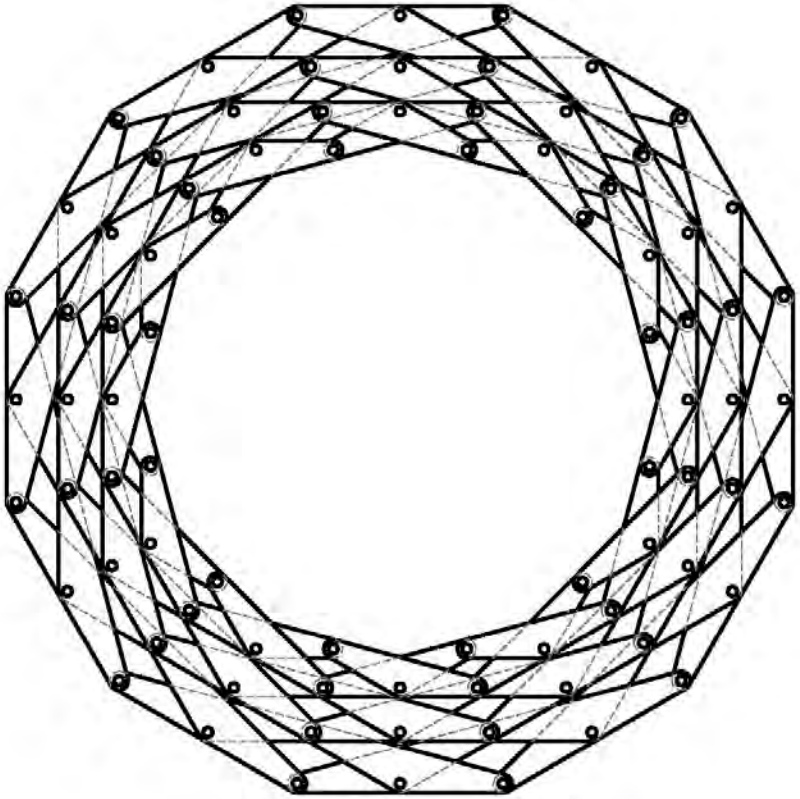


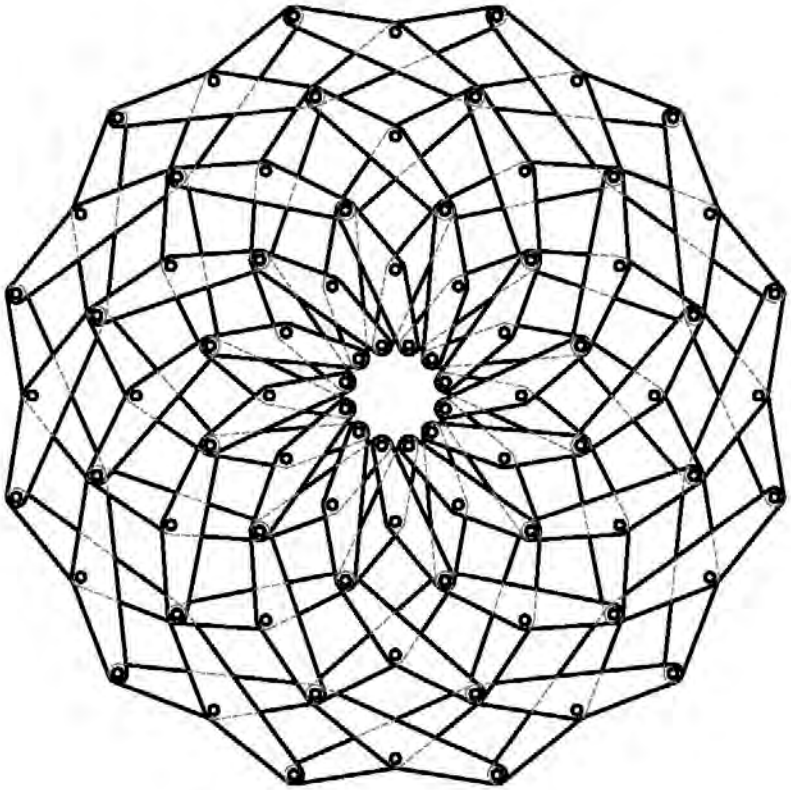




Iris structures

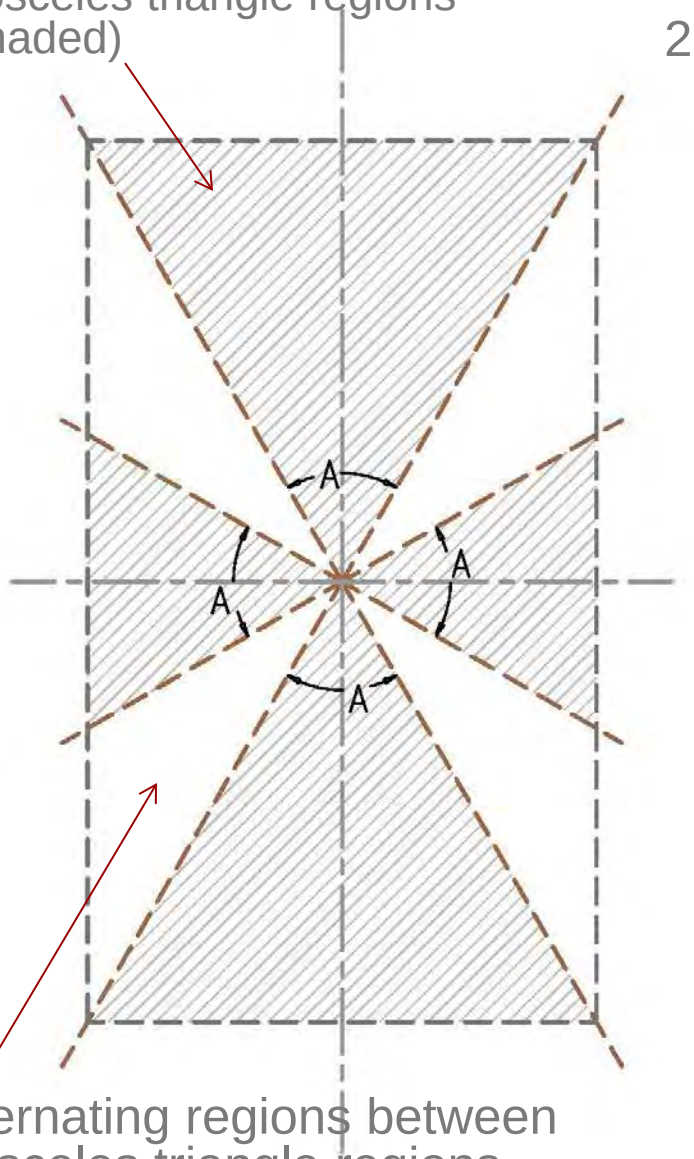
- Constructed circular iris





Non-circular iris structures

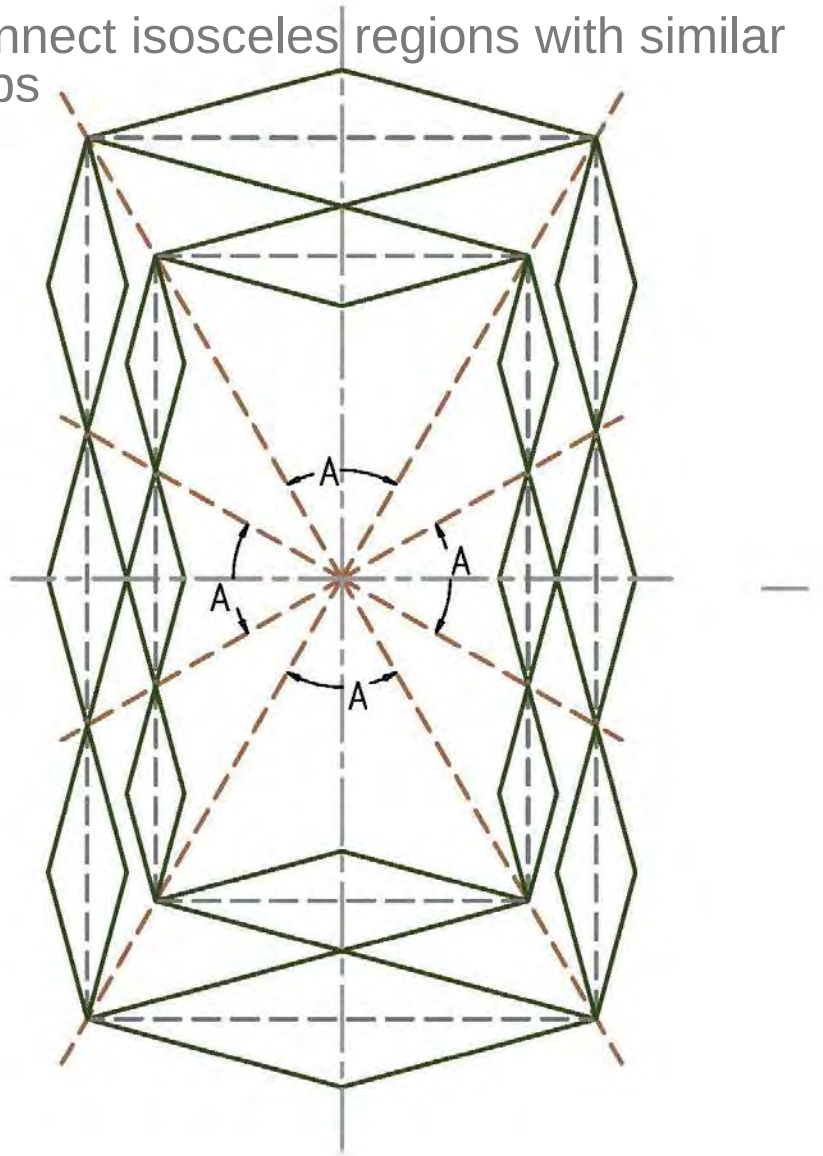
Isosceles triangle regions (shaded)



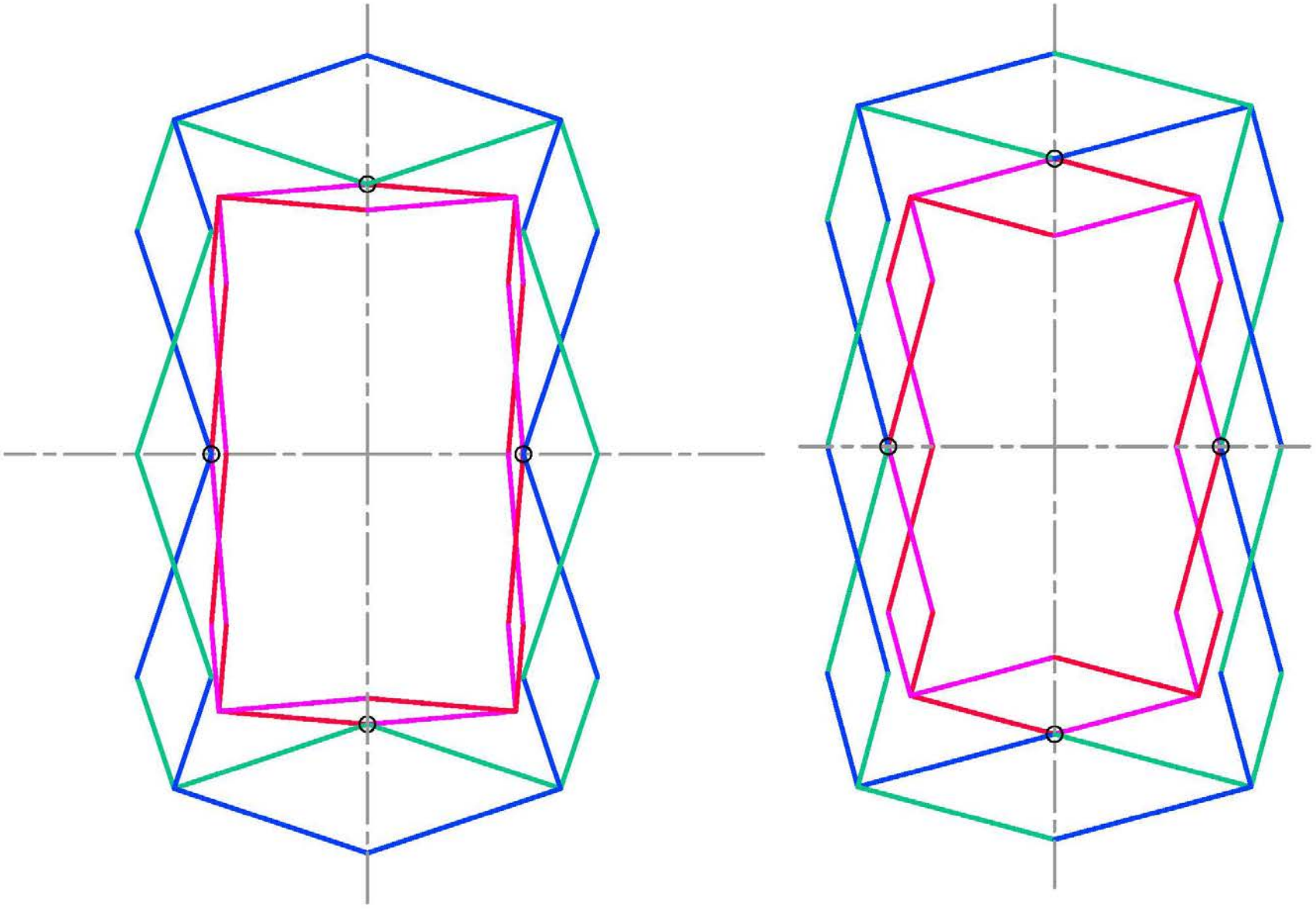
Alternating regions between Isosceles triangle regions (non-shaded)

To define retracted position

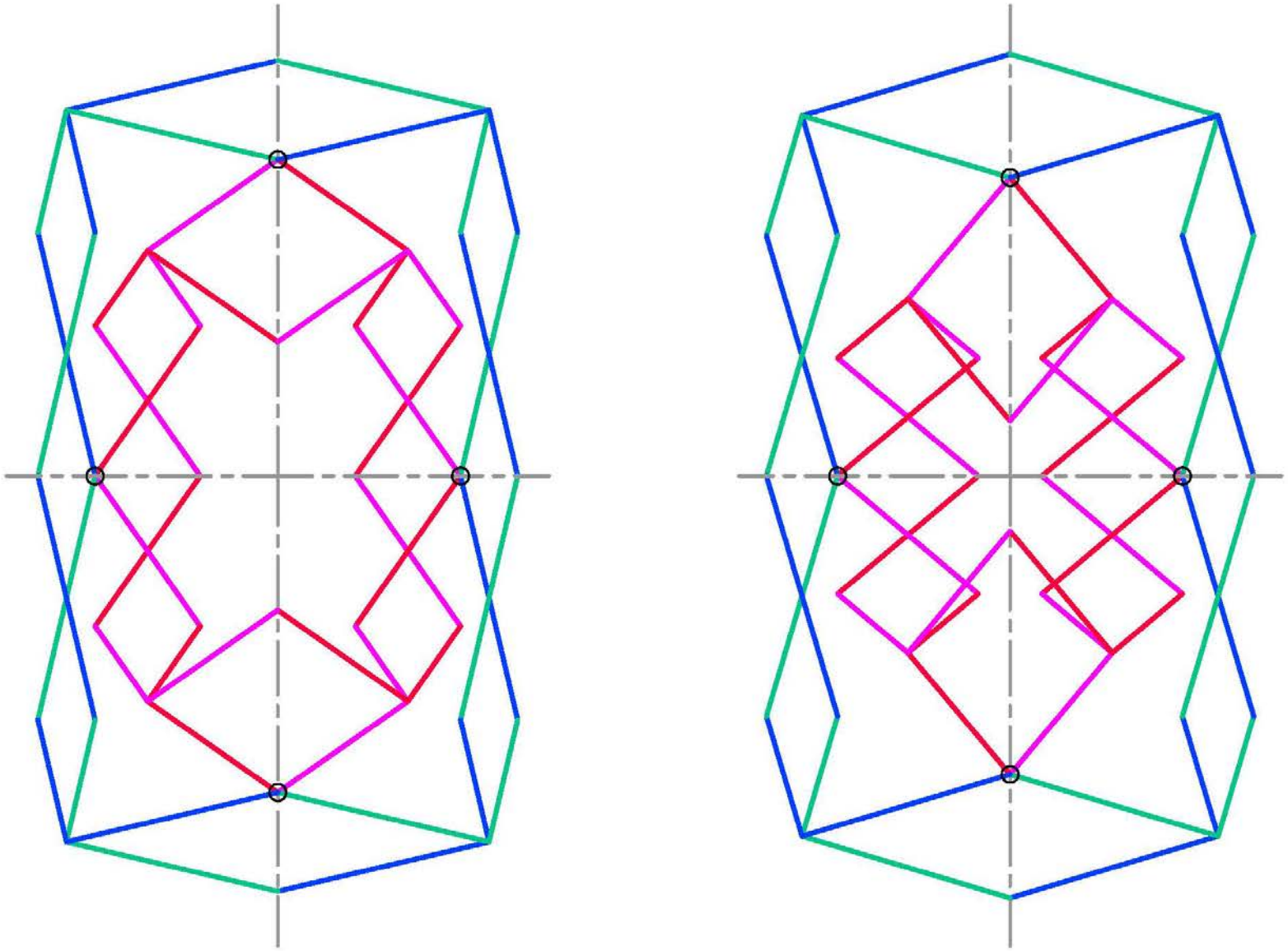
1. Create similar rhombs within isosceles triangles
2. 2. Connect isosceles regions with similar rhombs



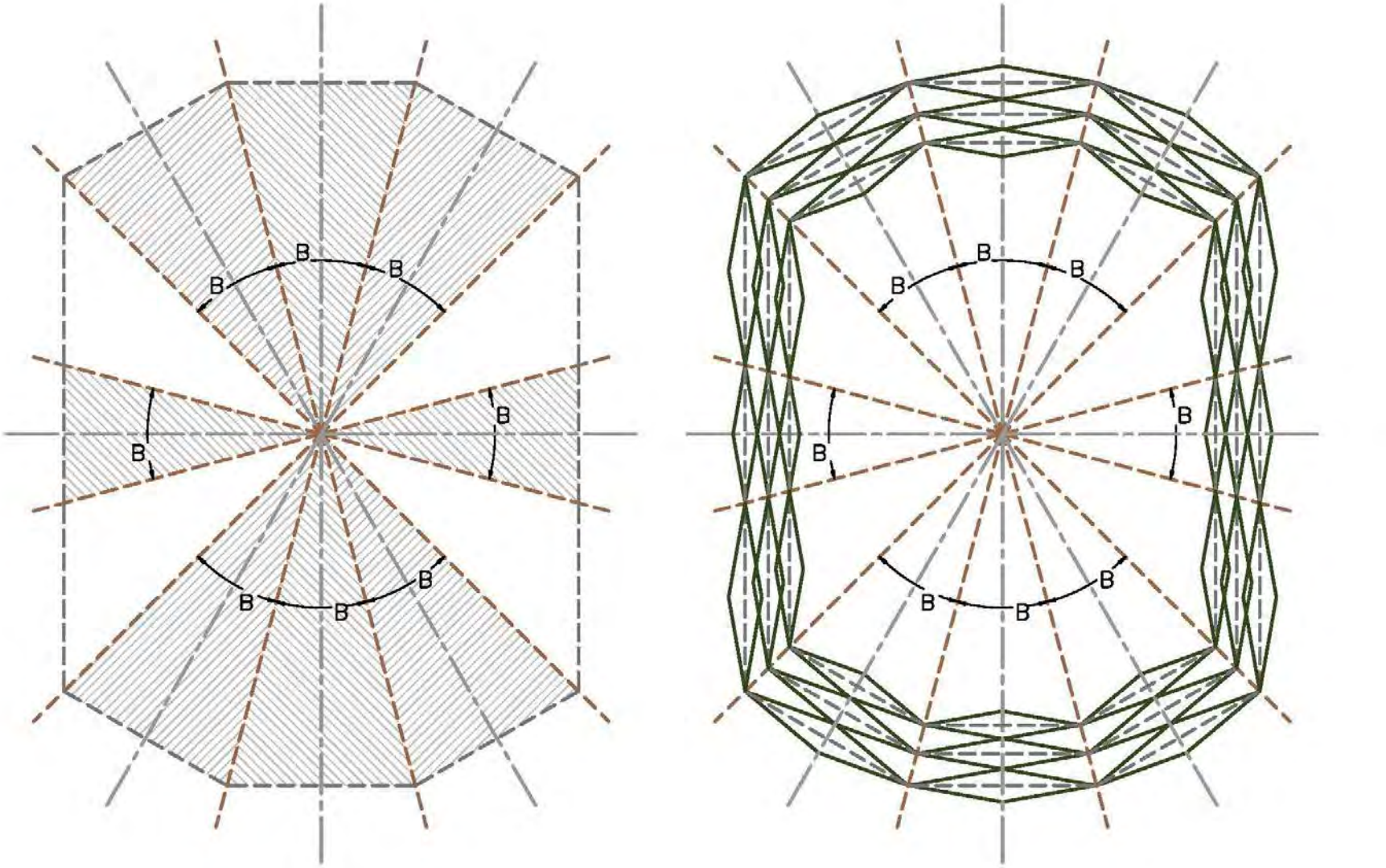
Non-circular iris structures



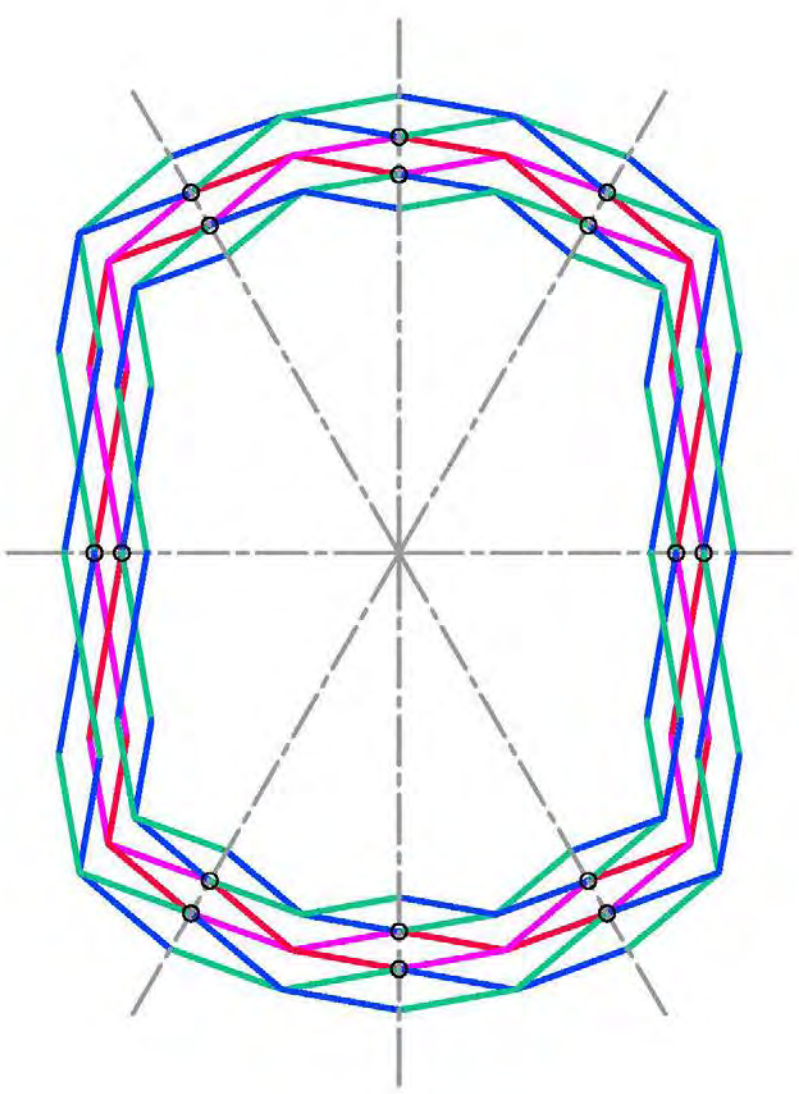
Non-circular iris structures

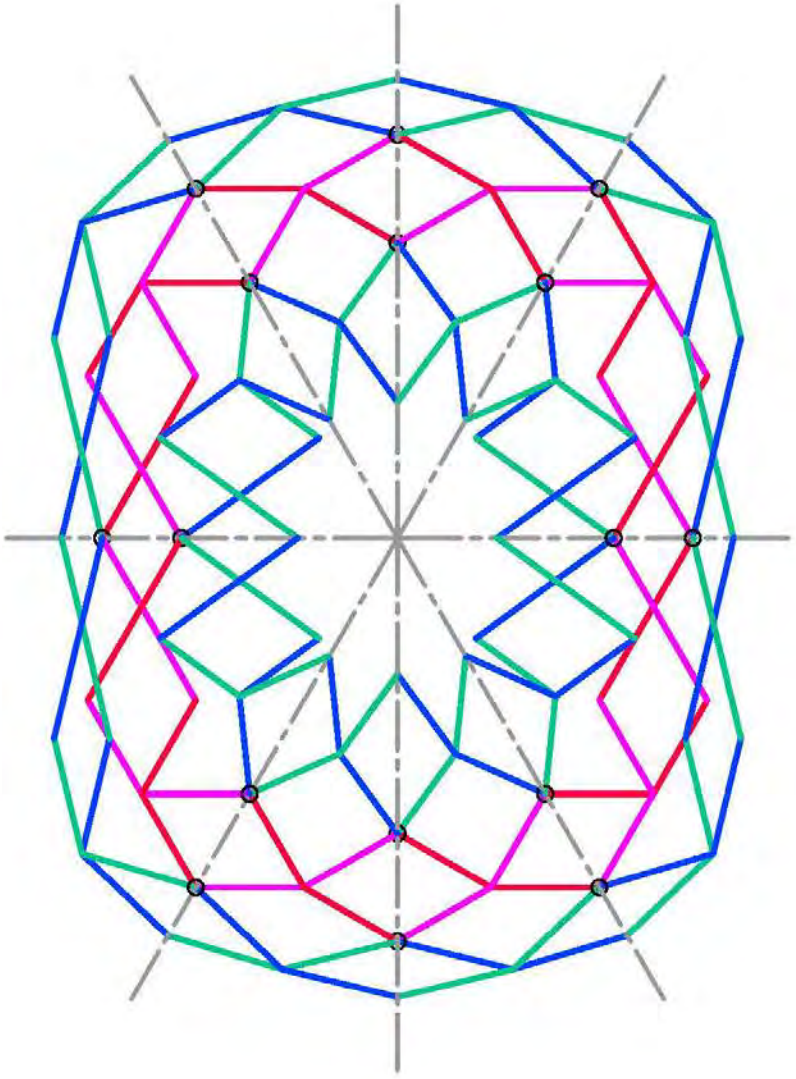


Non-circular iris structures

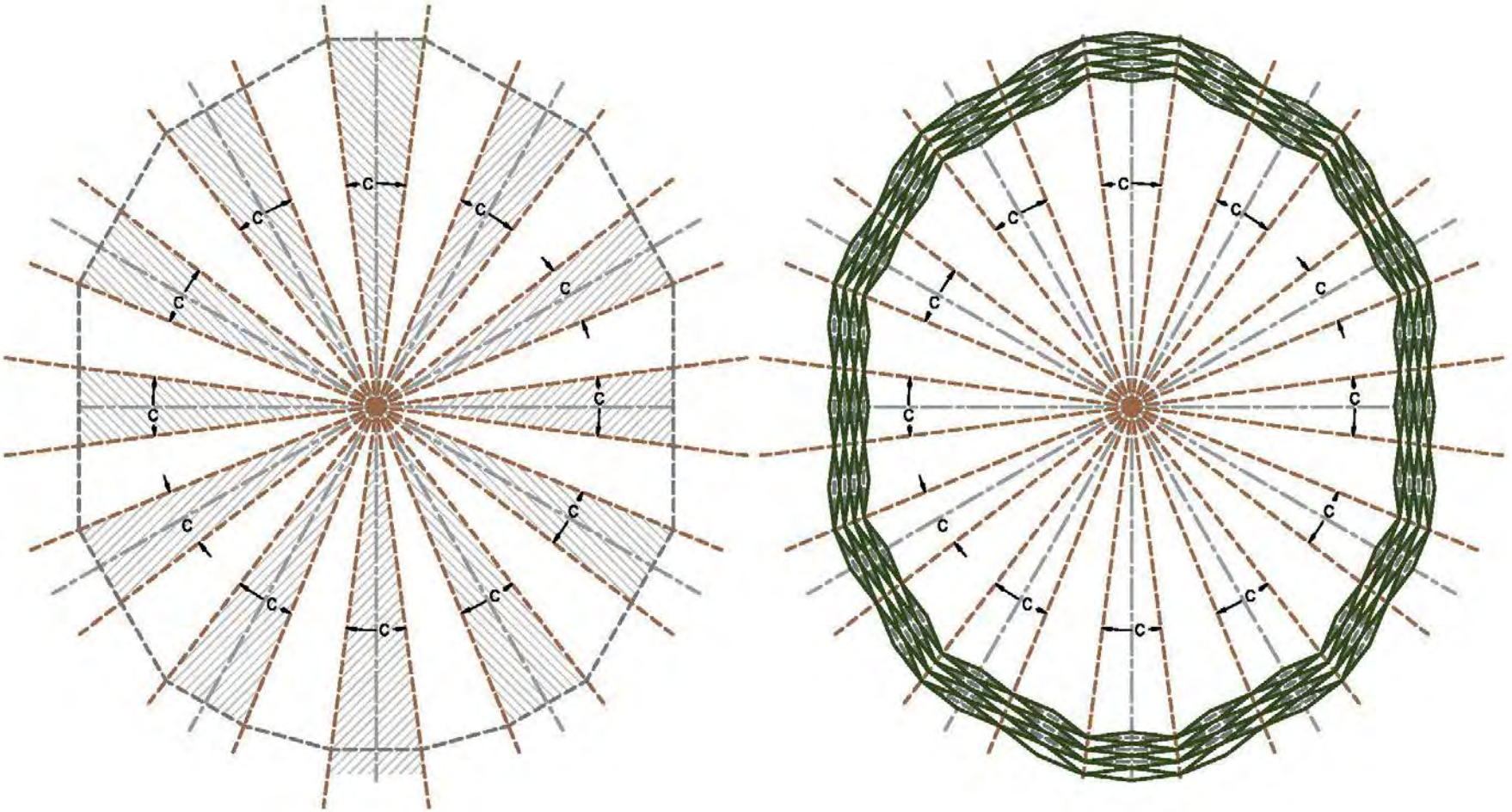


Non-circular iris structures





Non-circular iris structures



Non-circular iris structures