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Final Project: Theatre Interior Analysis

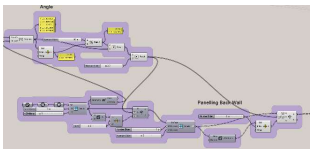
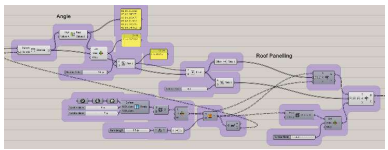
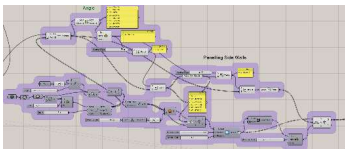
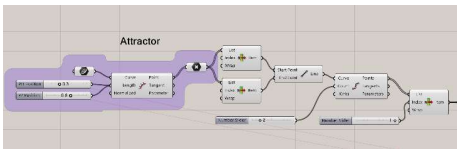
1. Design Problem

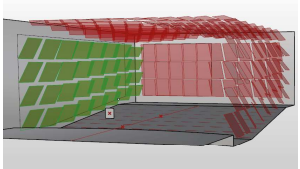
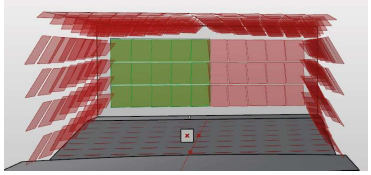
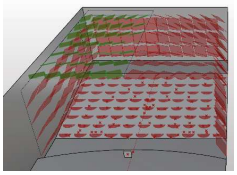
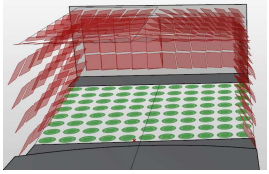
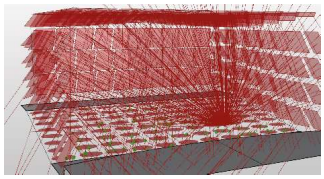
Our design problem is to solve for the ideal acoustics for a theater based on the placement of reflectors within the interior volume said theatre. We would like to begin with the 3D model of an existing theater, or a user supplied example. The investigatation entails a metric by which to evaluate if the current design is currently formatted for optimal acoustic considerations, allowing the user to assess alternative design options through the manipulation of reflector geometry, and the specification orientations at which to deploy the reflectors. This design problem intrigues us because it relates closely to our current studio briefs. The studios call for designing a theater with unconventional interior cladding (like crystals as well as a performance mandate subject to scrutiny through architectural guidelines and codes. It therefore becomes a necessary point of investigation to explore how surfaces and volume could affect acoustic values.

2. Analytical Approach

Our approach involved a number of steps allowing us to evaluate the geometry of the reflectors in the theatre space. First, we designated areas on each surface for reflector placement i.e. side wall, back wall and ceiling. After this we divide up these areas into quadrilateral panelling. With these panels in place, we then implemented a means of rotating them as a result of the movemement of two attractor points. These attractor points form the basis of the evaluation of the orientation of the reflector panels, as they act as the genomes with which galapagos tests the overall array.

After setting attractors, we located a source of sound on stage designated as a nonacoustically enhanced live performance. This point source was the origin for a series of vectors which project outwards 180 degrees in both the x, y and z axes to simulate the act of sound travelling. The vectors were then bounced off the reflector geometry and tested for interaction with the seating area. The seating area itself, is divided into a number of circles which represent the general area of hearing for each audience member.

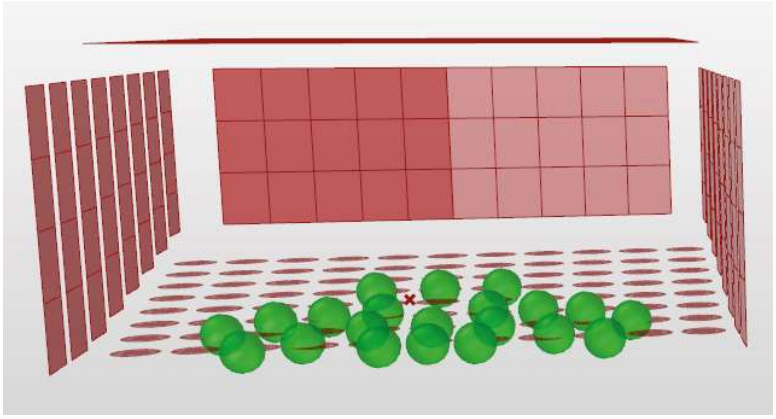





3. Evaluation

Before implementing any changes to the theatre's reflectors, we established a base case by which to measure the success of the geometry generated from the script. The initial percentage of vectors whose primary bounces fall within the auditory ranges of the collection of circles was 15.3%.

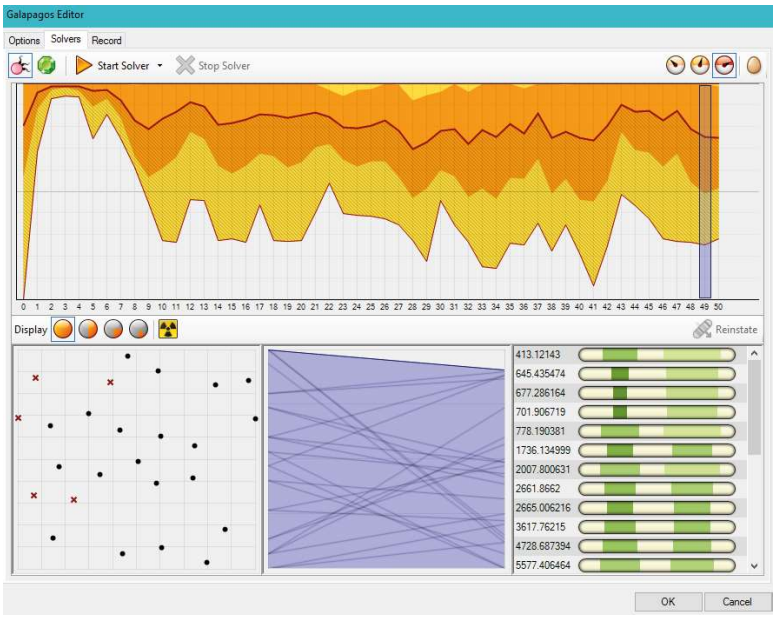
After running galapagos, the percentage of vectors increased by approximately 330%.

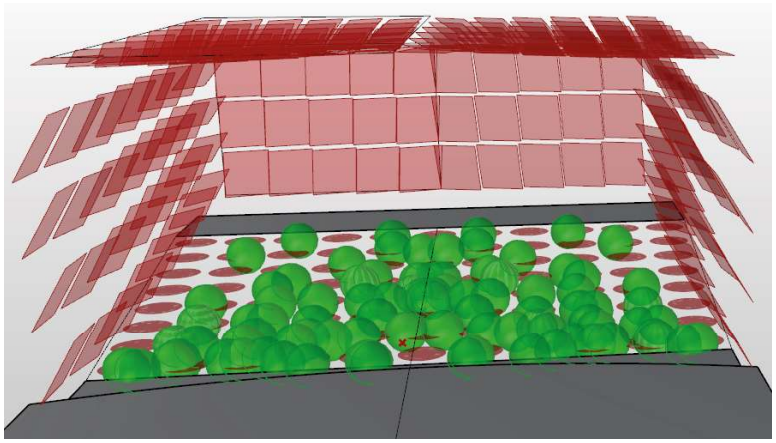


4. Caveats and Limitations

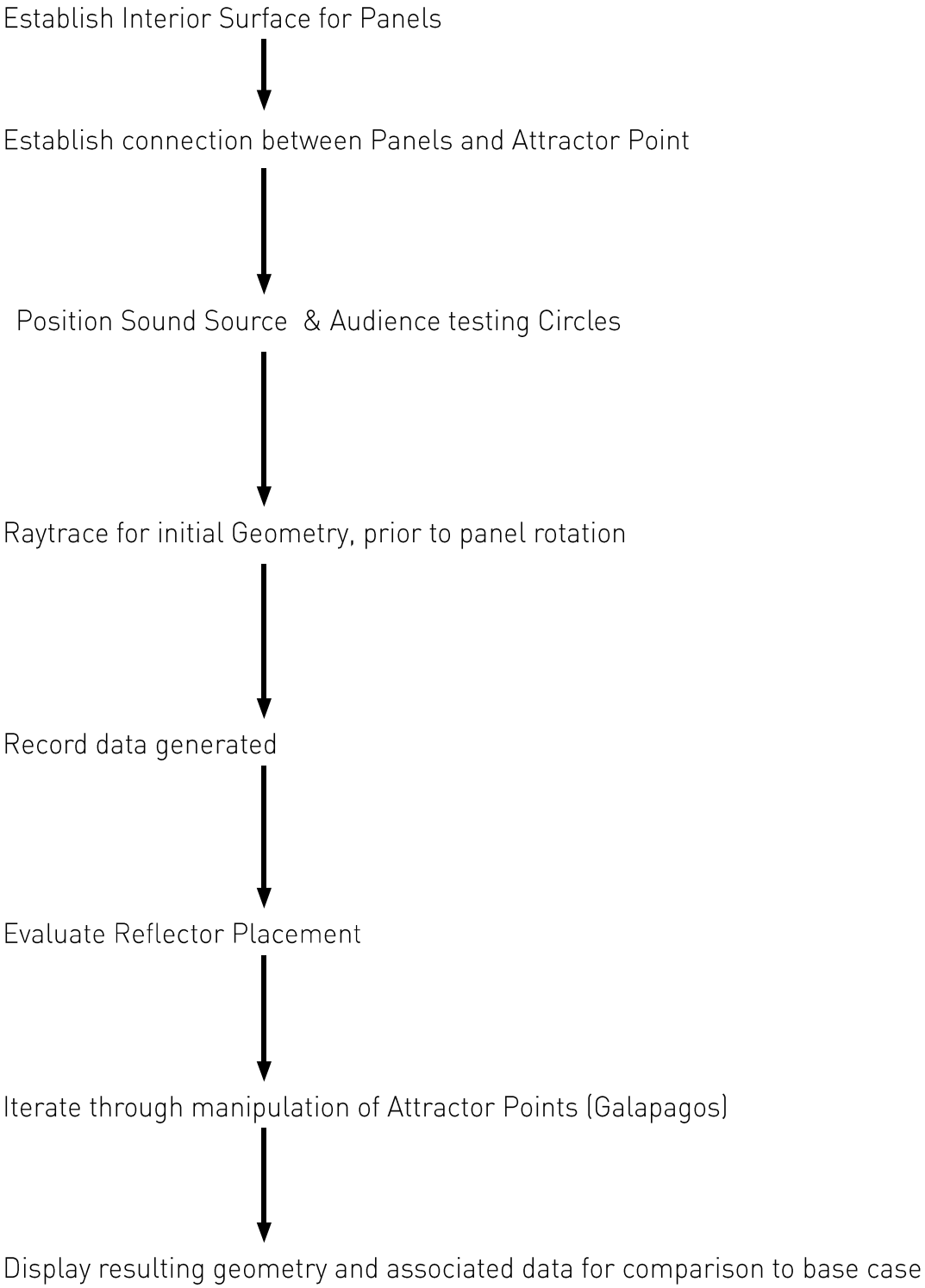
The number and size of panels as well as the radius of the audience ranges are constants and have direct impacts on the figures generated by the script. These constants may be changed in the generation of a new solution for other examples, which would affect the results.

The niumber of vectors projecting from the sound source is also limited, prohibiting total coverage of the entire space and affecting accuracy of the evaluation, especially considering the difference in behaviour of sound waves in comparison to vector rays.





3. Flowchart


Establish Interior Surface for Panels
Establish connection between Panels and Attractor Point
Position Sound Source & Audience testing Circles
Raytrace for initial Geometry, prior to panel rotation
Record data generated
Evaluate Reflector Placement
Iterate through manipulation of Attractor Points (Galapagos)
Display resulting geometry and associated data for comparison to base case