ZOOLOGIJOS SODAS

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Image Credit: Dara Lin
A Genealogy of Glass Architecture

Image Credit: Samantha Ung, Dara Lin, Robert Milkovich, Jake Olsen, Jesus Ramirez-Zambrano, Azuolas Skucas, Arjun Urbonas

In our “A Genealogy of Glass Architecture” timeline we draw a network of relationships between pioneering study of the history of glass and modernist architecture, the emphasis on a blend between the indoor and notably the 1951 Farnsworth House and Philip Johnson’s 1949 Glass House are prime examples of dis-glass architecture, our client couple encountered Mies and Myron’s unbuilt 1951 50x50 project, and
Architects/Engineers and their impacts on significant glass architecture of their time. In our outdoor environment has become a focus of interest. The works of Mies and Myron, most solving the boundary between the exterior and interior. In their own research about residential Myron’s unbuilt 1951 50x50 project, and combined with their love for living organisms, created the Zoological Garden.
Our clients, a Botanist and Ornithologist couple, envision an integration of their separate workspace into the residential environment. Our Botanist hopes to conveniently continue her research on exotic and native plants of Palm Springs. Therefore, an indoor exotic plant greenhouse and an outdoor native plant garden are designed to aid in her ongoing research. On the other hand, our Ornithologist wishes to have a bird observatory area large enough for various native species. Thus, an aviary is designed to be integrated into the atrium to accommodate space and multiple observation points. The use of glass becomes an important choice in providing the transparency that not only allows our client to conveniently observe their respective living organisms but also allow for that interior and surrounding landscape fusion.
INITIAL IDEATION

The unbreakable rules for the 50x50 house were as follows:

1. Square plan
2. No diagonals from the roof down to the ground as a Lateral Force Resisting System (LFRS)
3. No core touching the roof
4. Minimal exposed structure
5. Free plan spatial design of the building and site
6. No central forced air conditioning
7. Preservation of geometries and proportions that further a sense of ‘lightness’ and transparency, such that the opaque building elements might almost disappear visually
INITIAL IDEATION

INITIAL SKETCHES AND MODELS

Image Credit: Ąžuolas Skučas
INITIAL IDEATION

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Image Credit: Jesus Ramirez
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INITIAL IDEATION

1. Courtyard
2. Central Courtyard
3. Co-Example
4. Central Plant Enclosure
5. Plan
6. Concept
7. Concept
8. Concept

INITIAL SKETCHES AND MODELS

Image Credit: Dara Lin
For our roof, we decided to use a lightweight system composed of a steel deck, vapor barrier, insulation, and PVC membrane. The membrane comes in light shades to improve solar reflectivity for our building in Palm Springs.
For the foundation system, one of the major challenges in the previous models was making sure all of the offset floors act as one cohesive entity and do not shift between one another. We have decided to extend the footing wall of the upper floors to connect to those footing walls of the lower floors. For the columns, the footing for each vertical member will be an extension from the lower footing wall, as seen in the section views. This will form an offset between the column and the boundary of the house. This is feasible as we have already implemented overhangs into our roof plan. By skipping the upper slab, the columns will only be secured to the lowest base and make for more efficient constructability. The footings will have a layer of sand over a layer of gravel which will be separated from the earth with a vapor barrier.
A connection we found needed to be addressed was a typical beam to beam connection where the secondary member frames perpendicular to the primary member. Because of construction issues, the secondary beam cannot be coped and placed up against the web of the main member. The beam stops shy of the primary member on one side and is connected with an extended shear tab.

Another connection that arose because of our offset roof levels was the beam to column connections. We have the beams framing into the column and are welded at the flanges and the shear tab along with bolts. This creates a moment carrying connection.
Located in the Chino Canyon neighborhood of Palm Springs, California, the site’s extreme highs and lows make this desert climate an interesting choice for an all glass building. Nevertheless, we employed a few passive strategies to allow this building to adapt to its site. Our building is placed on a pretty exaggerated slope, on the upper most part of the mountain in this neighborhood. Being able to tuck into the mountain not only creates a great condition for privacy, but helps with some passive cooling strategies like utilizing natural shading from the mountain.
On the property, we have situated 3 planter beds on the site as laboratories for the botanist to study native plants. We also included a sunken-living room and fire-pit condition on the eastern corner for our clients to host guests and observe the view, as well as a two-level pool on the south-west face of the site that allows both the clients and the house to keep cool. These spaces and the house are all connected through outdoor circulation.
Diving into the layout of the building, if we look at the floor plan, we can see that the house is broken up into pieces that are separated by a 2’ elevation change. The house is broken up programmatically by these elevation changes, but the lack of doors between spaces allow for some blurring of the lines between them.
In the program diagram, you can see that the project is split into its 4 quadrants, but that each programmatic space is integrated with its adjacent spaces. In the circulation diagram, you can see how one would get around the site and around the project. Lastly, this green-space diagram shows the dedication of space in the project to both the botanist’s and the ornithologist’s professional needs, allowing them to work from home.
Entering from the north-east face, you enter into the workspace area. Moving counter clockwise is the kitchen, connected to the living room through a double sided table. The living room includes a double sided couch, further emphasizing the usage of mixed programs. This leads to the master bedroom, with some opaque bathroom walls creating a bit of privacy, and then centered in all of this is an outdoor aviary with a caged roof.
This jogged section cut shows the entry sequence of the project, from the street up the driveway, along the outdoor circulation, and then through the house. Obviously this isn’t a linear cut, but demonstrates an occupant’s experience through the project.
This parti massing diagram shows how we ended up with our final design and how it progressed over the term. As you can see, we started out with a 50’x50’ box, and then added a central aviary courtyard for both programmatic purposes as well as daylighting, circulation, and ventilation strategies. We then continued by dividing the box into 2 L-shaped pieces and separated them vertically. We then broke up the pieces into separate programmatic spaces, and reached our final design by fleshing out the connections and details between these spaces.
EXTERIOR PERSPECTIVE, EAST

Image Credit: Dara Lin

The entrance on the east side is one of the key connections to the outdoors, as this quadrant is also the greenhouse and the workspace of the botanist. At the corner between the two gardens on the most public-facing orientation, there is a sunken seating area, intended as a sheltered fire pit.
The driveway comes to the north corner, terminating between the northeast and northwest planter beds. There is a clear view of arriving visitors from the kitchen, as pictured. The outdoor paving broadens as it steps upwards towards the rear of the house.
This pair of images demonstrates the differing light conditions between daytime and nighttime. During the day, the glass is almost completely transparent, blurring the boundary between the living room space indoors and the patio outdoors, and there is ample daylight despite the deep overhangs. Then, during the night, due to the illumination within the house and the darkness outside, the glass becomes reflective, obscuring views to the outside. (Note: these images were not intended to reflect a binary condition; as one reviewer pointed out, there is a spectrum/continuous range of lighting conditions throughout the day.)
This face of the house is the second moment where the indoor-outdoor connection is most prominent -- the paving around the house, which is level with the indoors, broadens into a wide plaza, perfect for guests to spill out of the living room on the left, into the pool area on the right. The paving narrows once again as one descends from this patio to the next quadrant, where the bedroom is located.
INTERIOR PERSPECTIVE, FACING NORTH

In an unhindered framed view, the existing neighborhood is visible below to the northeast.
On the left, the botanist’s work area features a walk-in environmentally-controlled greenhouse on the perimeter of the quadrant and a worktable in the center. The courtyard and aviary are accessed via the same quadrant. On the right, the kitchen counter runs along the perimeter of the quadrant, with all appliances located below counter height.
The following passive strategies were considered for this building.

1. The siting strategy was to half-sink the building into the hillside to amplify the self-shading effect of the sloped site.
2. Bioswales as a low impact development strategy to gently direct uphill water away from the building while keeping it onsite, instead of causing erosion through runoff.
3. The pool is placed on the southwestern and windward face, in order to mitigate heat gain as a thermal mass and through evapotranspiration.
4. Also taking advantage of the prevailing western wind, the building is cooled through cross-ventilation.
5. The floor of the building -- a concrete slab on grade -- also serves as thermal mass.
6. The planted atrium and exterior gardens improve air quality, introduce moisture into the air, and provide cooling through evapotranspiration.
7. The light-colored PVC membrane is a cool roof.
8. The overhangs are sized to block sunlight during the overheated times of year, while allowing sunlight to warm the space during the cooler winter months.
This section shows the roof structural system and slab-on grade condition, and demonstrates the location of three key details: the roof assembly, the mullion-to-beam connection, and the sliding glass door-to-slab connection.
Since the roof is carrying only its own weight but we are having quite large overhangs, we thought about going with the lightest roof system possible. Roof detail itself will be presented later. Unusual structure forced us to come up with an atypical load path system, so to clarify it our girders, which are laterally braced, and secondary beams are both wide flange sections. All members are flush. For columns we chose to go with HSS section instead of the usual wide flange because of its benefits withstanding buckling in both axes and better resistance to overall torsion. Our light roof system gave us a dead load of 7 psf, for live load we used 20 psf. Seismic and wind loads were also incorporated into the SAP model according to our location. Regarding nodal deflections the biggest one (excluding the overhangs) is at grid point B-2. It deflects no more than 2.5 inches under the harshest load combination. All sections were designed and examined using FEM software according to AISC-16 design code. Even though from the first sight it can look like it’s 4 repeating roof patterns, the asymmetric overhangs and different column length makes each quarter unique.
This section shows the buildup and encasement for the roof at the exterior.
The angled beams provide us with challenging connection details while considering the constructibility of our project. In this example we are looking at a typical corner connection, where we have designed a gusset plate bolted and welded on both the top and bottom of the members with a hollow shim to allow for variance in member sizes. Welding the gusset plates to the beams allows this to be a moment carrying connection.
For our glass connection, we have decided to use a slotted connection where the upper track slides and locks into an angle attached to the column, where the glass can then be placed within the track. Our next slide shows an enlarged detail of our connection. Some notable components to this connection include a plastic bracket to provide a thermal bridge to our structure, a spring within our track to allow for further deflection, and double pane glass to decrease solar radiation into the building.
On the left is an axonometric of our glass connection to the roof. To improve constructibility for this, the steel angle will have larger slots so that adjustments can be made on the field.

We have three different conditions of the glass at floor finish, the top where the concrete is aligned at both interior and exterior, the middle where the exterior is exposed, and lastly, the bottom where the interior of the glass is exposed.
When talking about the connections, it is important to understand if they meet up with the forces they are seeing.

Both Connections were designed to be in compliance with the American Institute of Steel Construction’s 2016 Steel Construction Manual. Reference to the tables used are placed with the work above.

All connections seem to satisfy the load they see as the Demand/Capacity ratio for the connections are well below 1.0. If we say that the bolted connections do not work, a possibility is to add a web stiffener for the connections because the limiting factor is the Tension Rupture of the beam’s web.

### Bolted Connections

**Image Credit:** Jesus Ramirez Zambrano

### Base Plate Connections

**Image Credit:** Samantha Ung
For this artifact, I wanted to capture the atmosphere surrounding our glass house. I wanted to create a drawing that emphasized the large horizontal lines of the roof plane while keeping the site in the background as a looming force. Thus, I created a Big Moody charcoal drawing, as a way to not only remove color and focus on shape and shade, but create a mysterious version of our project where transparency and occupation could be questioned.
For the artifact, I wanted to represent how nature is strong against all conditions. In this hypothetical world, all humans have abandoned the area and left everything to decay. Well the building pictured, modeled after our project, has started to decay and be torn apart by nature while the fauna seem to thrive. It is made possible because the plants the botanist was studying were native plants.

Painted on several glass panes, it creates an illusion of depth. It also aids in giving space to add new panes which create this illusion of the passage of time.
Charles Sheeler (1883-1965) was born in Philadelphia. He had a background in industrial drawing, but was also traditionally trained in art. In his early career, he was a architectural photographer, notably collaborating with photographer Paul Strand in his short film Manhattan, which emphasized the dramatic viewpoints and abstract compositions of the New York cityscape. Scheeler’s own work became an emblem of Precisionism, where compositions were reduced to simple shapes and underlying geometrical structures, with clear outlines, minimal detail, and smooth surfaces. Precisionist art conveyed two viewpoints on technology: the way it brought order to the modern world by enhancing the speed, efficiency, and cleanliness of everyday life; versus the way it dehumanized workers, created pollution, and dominated the landscape.

Sheeler created his compositions by overlapping two or more photographic negatives of the same subject, and then transferring the resulting, synthesized image to a canvas. In doing so, he explored the relationship between the exactitude of photography and the layered, re-created perceptions of painting or drawing.

This artifact used the same method of overlapping two views to create a synthesized composition.
For this artifact, I wanted to create a paper mosaic of the Zoological Garden by tearing pieces of colored cardstock and sticky notes and layering them above one another. The colored background in particular is a reflection of mosaic glass art that creates a contrast to the grey orthogonal view of the structure. For further contrast, the yellow core is left untouched.
For my artifact, I wanted to represent the linear aspects of Miesian architecture that our Glass House has gained so much inspiration from. Furthermore, I wanted to use a tessellating language that would read as a 3-dimensional polyscape. Our project in particular made use of varying floor levels and I wanted these staggered segments to read well in my artifact. The blue color pallet is to represent the nature of the glass material that surrounded our walls, while the black planes represent the more solid roof elements.
The 50x50 feet house project by Mies and Myron was a flexible evolution of the Farnsworth house that proposed a modular system to improve affordable housing. The house was intended to adapt to different families and sites. It could be built in different sizes with different core. This was an unrealized project. For my artifact, I have created our interpretation of Myron and Mies’ 50x50 foot house. Using acrylic on glass, I was able to relocate the house to show it in different areas.
According to the American Psychological Association, 40-50% of marriages in the U.S. end in divorce and in our vision for final fantasy, our clients have unfortunately become a part of this statistic. However, divorce doesn’t always mean you can magically afford two houses, so the two have attempted to escape each other’s presence by building up and away from each other.

In particular, the botanist, viewing his marriage as a lost cause, has instead devoted his attention to preserving the last giant sequoia ever, placed in the center atrium of the project and lavishing time and care so that it can grow taller and taller. The house has thus grown with the tree, and to follow this concept, our 50x50 glass house has been reimagined as a vertically stacking module, creating separate duplicates of spaces that were once shared. Refining the existing emphasis on the connection between indoor and outdoor, nature is used as both a barrier and a connection, paralleling the complicated dynamics of a broken marriage.
This view from the eastern corner demonstrates the stacking of the floors. The original roof overhang has become an exterior wraparound balcony, preserving its shading function and serving as circulation around each floor. With the dissolution of the marriage, the first floor, once shared, has now been abandoned, and the house has been overrun by greenery.
This section is taken diagonally through the project, cutting from the north to south tip and facing west. As you can see, the sequoia tree and its central atrium really are the focus of and the binding condition of the modular units for this design. Not only is the vertical circulation built around this, but the entirety of the project is based on designing rings around a center atrium which increase upwards through modules. Additionally, some technical aspects you can see in this section cut are the varying programs; that being the public, abandoned original glass house on the ground floor, and then the botanist’s living quarters on the second floor, then a shared and public half greenhouse and half bird sanctuary on the 3rd floor, and lastly, the ornithologist’s private living quarters on the fourth floor. To reinforce and make this modular approach more feasible structurally, we came up with a few upgrades, such as: reinforcing the columns by making them composite, installing vertical tension cables on the interior corners around the atrium, and having the elevator frame acting as a structural core. Additionally, what used to be a roof system will be transformed into a light concrete deck using the same corrugated steel sheets that are already in place. Most of the insulation can be transferred and reused for a new roof system. Lastly, because our final fantasy project is based upon our initial Miesian design, the foundation design can remain largely the same. Both the original house and the new fantasy project share the same footprint, as the final form is essentially a continuation of the previous building. Deep foundation elements like caissons will be used to satisfy the additional demand.
The atrium is the only space still occupied by both the botanist and the ornithologist, as their subjects of study share the space. It represents the enduring nature of their connection, despite their determination to part ways.