

The challenge of joining structural engineering with the solid surface thermoforming

Organic SLO_GEN table - made with HI-MACS® - amazes visitors at Gensler offices



The **SLO_Gen** communal table is the new focal point of **Gensler's** Los Angeles office lobby, and the result of an innovative partnership between Gensler and the Department of Architecture and Environmental Design at Cal Poly, San Luis Obispo (California).

In order to achieve the stunning and outstanding curves, **HI-MACS®** turned out to be the key material thanks to its thermoforming properties, resistance, seamless joints and the smooth surface, which convinced the architects and engineers from the first meeting.

HI-MACS® Media contact for Europe:

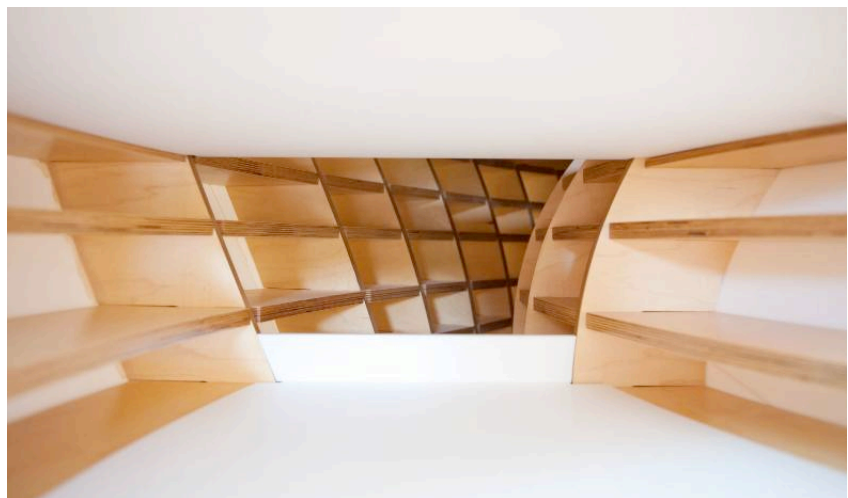
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High resolution photos available at www.himacs.eu/press



In 2011, professors **Jim Doerfler** and **Mark Cabrinha**, co-directors of Cal Poly's Digital Fabrication Lab ("d[Fab]Lab") reached out to Gensler L.A. design director Shawn Gehle to create a fully-virtualized studio focused on digital fabrication and online collaboration tools.

In response, Gehle authored a unique, 10-week seminar that would allow students access to the firm's design talent and explore form-finding and digital fabrication techniques through the design of a custom furniture piece.



The design brief simply outlined a piece that could accommodate standing and sitting space for guests and storage for the firm's design publications. The piece would need to be site-specific and prominently featured in Gensler's new downtown Los Angeles office.

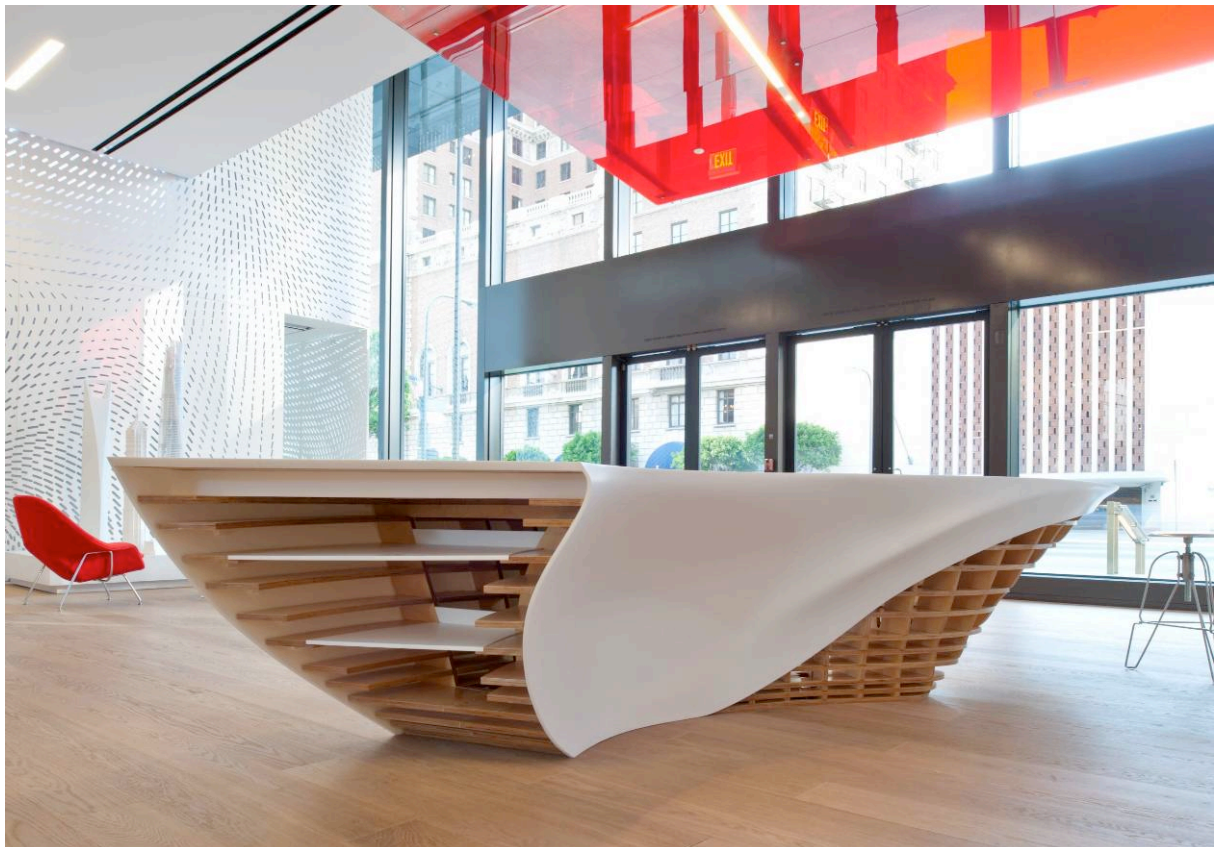
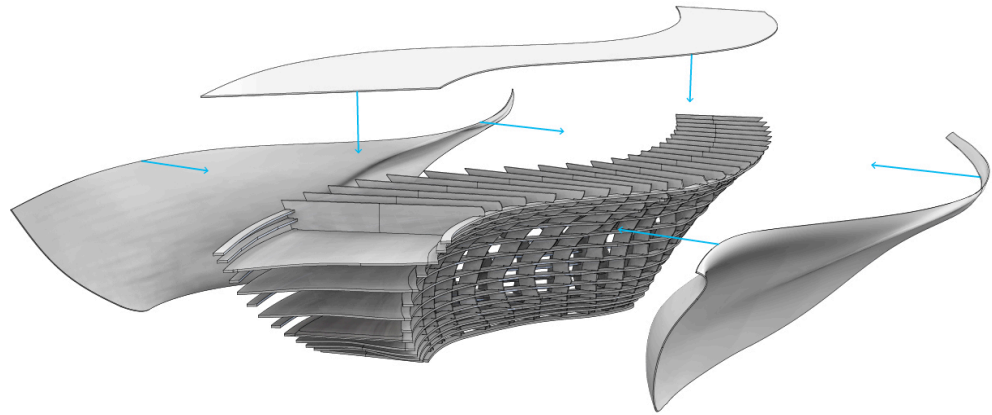
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A virtual 3D prototype

Beyond an initial in-person meeting, Cal Poly students and d[Fab]Lab faculty met with Gensler advisors via the online collaboration tool GoToMeeting to conduct weekly seminar discussions and review the team's progress. In addition to bridging the 300-mile gap between designers in Los Angeles and students and faculty in San Luis Obispo, this method allowed professional consultants and materials specialists to participate easily, while exposing students to the kind of virtual collaboration that is prevalent in professional practice today. Maintaining a focus on a digital workflow, the team's design and documentation process also was conducted virtually, substituting a 3-D model as the deliverable for fabrication in lieu of a traditional set of 2-D drawings.



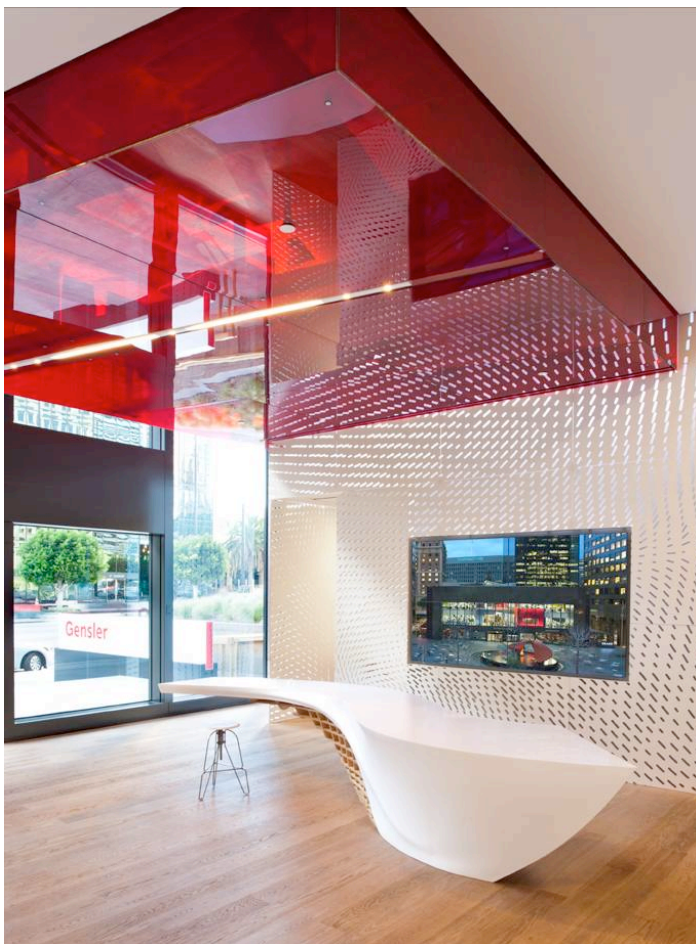
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Over the course of the seminar, the original concepts of three students were developed and refined using the 3-D modeling software Rhino and T-Splines, and virtually reviewed and critiqued weekly with Gensler's design staff.

Structural engineers at Buro Happold and **HI-MACS®** solid surfacing material provider LG Hausys joined multiple discussions to examine schemes and offer insight on constructability, cost and structural integrity. A final, in-person meeting in Los Angeles focused on the review of physical prototypes and material samples, and enabled the team to address the challenges of forming fiberglass vs. Solid Surface **HI-MACS®** as the table's predominant surface material.

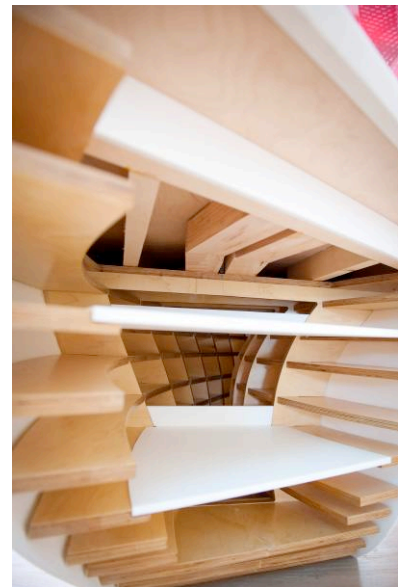
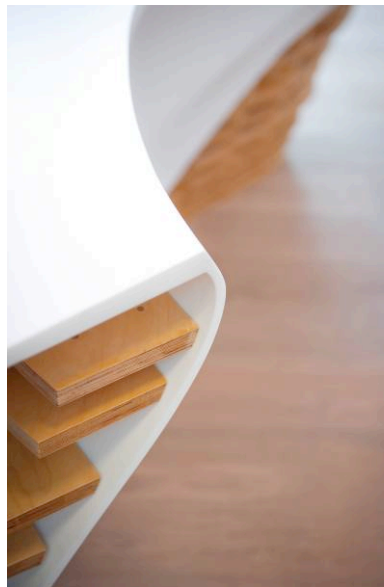


Inspired by the design and opportunity, **LG Hausys** became a partner in the project, providing technical expertise and support for their HI-MACS® solid surface material, which proved to be the ideal material for achieving the table's draped surface. LG Hausys also introduced the team to the capabilities of R.D. Wing Co. Inc., the Seattle-based fabrication specialists who ultimately constructed and delivered the table's design.

The SLO_Gen table was recently installed in the main entry of Gensler Los Angeles, where its dramatic profile continues to lure pedestrians in from the street and prompt conversation on its origin. Thanks to the HI-MACS® outstanding capacity to be combined with other materials, the combination between the white colour of the solid surface with the natural Wood creates a soft and elegant contrast.

Integrate the Plywood with HI-MACS® solid surface

Cut paths for the table's plywood ribs were extracted from the 3D model and laid out onto 1,2 x 2,4 mt sheets of Europly for CNC machining. The table required 12 sheets of plywood to cut all the rib pieces. During the machining process, tabs were left along the edges of the ribs to connect them together and to stabilize the falloff. These were ultimately cut, filed, and sanded by hand. The reason for this fabrication method was to hold down the shapes while machining, keep them from shattering, and not damaging any of the surface faces with tape or screws. After cutting off the tabs, the ribs were then varnished to a satin finish. Once the varnish dried, the eggcrate was assembled by hand using a mallet and dados.



HI-MACS® thermoforming and integration with Wood

Beginning with an S-shaped top, 4 separate pieces of HI-MACS® were milled on a CNC router. This number was due to the size limitation of the stock material and overall size of the table. The individual pieces produced were then glued together and sanded flat, acting as the only “flat” portion of the table’s solid surface.



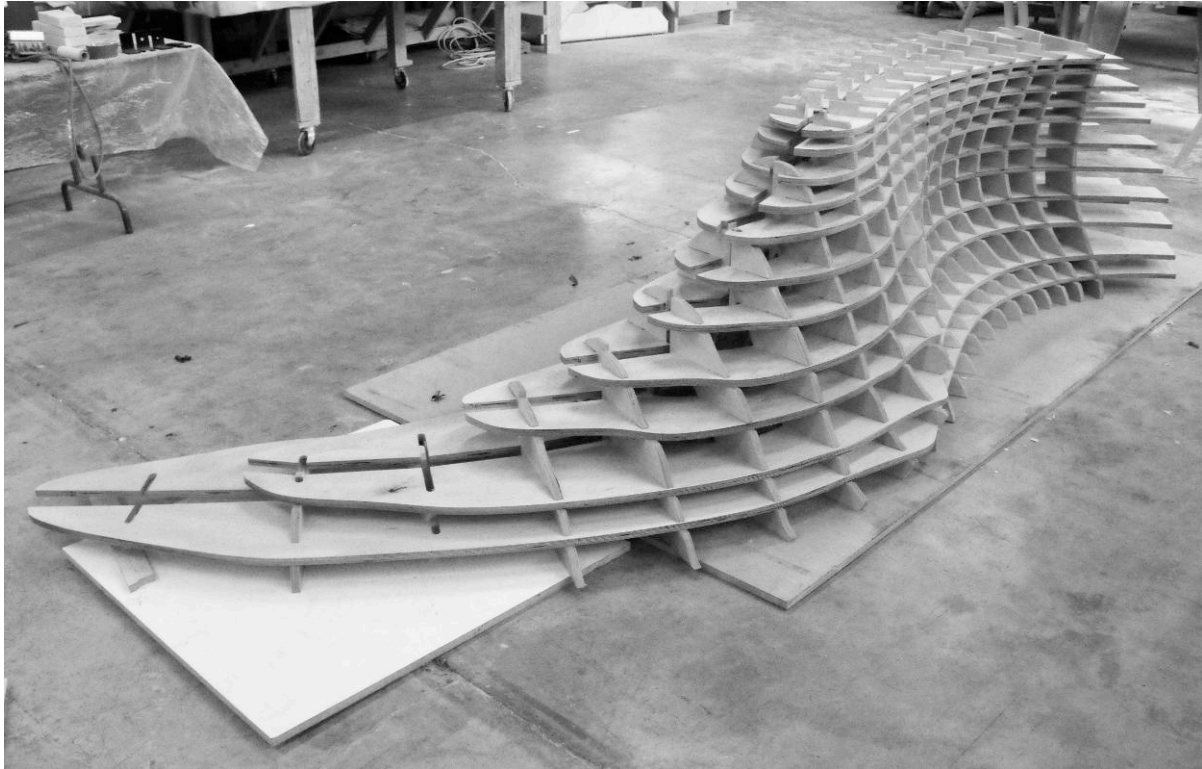
A 1,5 mt-wide strip (in multiple pieces) was machined to follow the curve of the table’s surface. This strip was used as a back-up strap where the table’s sidewall would meet the underside of the top. This strap was glued into place, with rolling undulations machined into its profile to assist the shop later in aligning the sidewalls later in the process.

Given the severity of curvature in the table’s HI-MACS® sidewall panels, deciding how to panelise and form the surface proved critical. This step required determining which portions of the solid surface could be machined to shape without moulds, which required moulds and of what type, and also where and how to best panelise the table’s shell to optimize the material provided by **LG Hausys**.

To optimize the material, increase the workability of the solid surfacing and address individual nuances, each side of the table was broken into 5 sections based on the topography of the individual surface. R.D. Wing created a mixture of moulds – with no two moulds being the same - to fabricate each sidewall. The only way to achieve the most complicated portions of the sidewall with solid surfacing was to utilize a clamshell mould,

allowing the solid surface material to be thermoformed by simultaneous pressure applied from both the front and back. This technique required two moulds be milled for each section formed - a male and female, and additional consideration had to be given as to how large the moulds needed to be (and therefore how much material would be required).

To create the thermoforming moulds, R.D. Wing used 15-20-pound polyurethane foam, left over from other projects. The sides of the foam moulds were left unfinished, and because of this the moulds for each section could be used up to 10 times if necessary. The foam was mounted to an MDF base and milled with a CNC router in stacks of 1,27 cm. Each layer was machined, and then a new layer of stock added on top of it. This process was repeated until an entire mould was made. A tight machining step-over was used to eliminate the need for sanding. A trim line was added around the perimeter of the moulds so the shop could see how one panel would fit to the next. Once all the moulds were machined and cleaned of excess foam, a layer of cotton was added to the surface for heat dispersion.



For the largest portions of HI-MACS® requiring thermoforming in two directions (complex curves), the pieces were first heated, and then placed within the clamshell mould. Of the 5 moulds, it took 12 individual HI-MACS® pieces to make all the sides. There was some trial and error that went into deciding how many individual pieces were needed. After they had the 12 pieces roughly formed to shape, they put them back into the mould and began laying them out for the final trim. Each piece was trimmed to the corresponding piece and, using the form, glued together. The smaller pieces were seamed together until there were 5 main pieces.

The side pieces were pre-glued into 5 usable pieces, then fitted onto the sides of the wood structure. The sidepieces were matched to the underside of the table against the seam strap included in the top surface, keeping the sides firmly against the wood structure, and pulling everything together for seaming.

The next step was to cut the bottom flush and the side that faced the shelves, then cut the seamed side straight and create a flat edge to bond to the underside of the table. After bonding the first section to the underside of the table and silconing the back of the first section to the wood structure, the next section was pre-fit to the underside of the table and the corresponding section. This approach required cutting the shape with as little gap as possible, then hand filing it to the final fit. Once fitted tightly, the process was repeated around the perimeter.

After all the sections were glued together, all the exposed surfaces were sanded. The final step was to finish sand the entire surface and fix minor imperfections.

Once fabricated, the entire table was mounted inside a custom built crate for shipping and delivery.

For more information, check out the [video](#) about this project



PROJECT INFORMATION

Project:	SLO_GEN table
Location:	Gensler Los Angeles, Los Angeles (California, USA)
Design:	Cal Poly, San Luis Obispo, Department of Architecture, College of Architecture and Environmental Design www.arch.calpoly.edu Faculty: Jim Doerfler, Mark Cabrinha Students: Ben Hait-Campbell, Cory Walker, Kegan Charles Flanderka Gensler Los Angeles www.gensler.com
Engineering:	Buro Happold: Garrett Jones, Gary Lau, Greg Otto, Liz Mahlow www.burohappold.com
Fabrication:	R.D. Wing Co., Inc. www.rdwing.com
Material:	HI-MACS® www.himacs.eu
Photo credits:	©Gensler Los Angeles

WHAT IS HI-MACS®?

A new generation acrylic stone, **HI-MACS®** is a material that is designed and produced by **LG HAUSYS**, a world leader in the technology sector, and distributed by **LG HAUSYS EUROPE**, based in Geneva (Switzerland).

Due to its thermoformable properties, its wide range of colours, its translucency and the invisible joins, HI-MACS® is able to provide an infinite number of designs and exclusive finishings. Moreover, this material can be worked as easily as wood as it is easy to handle and to cut.

As regards hygiene, HI-MACS® does not absorb humidity and is highly resistant to stains. Its smooth and non-porous surface means that it is not penetrated by liquids. Completely sterile, this material is easy to clean and to repair: small scratches can be removed simply by using a sponge or a soft cloth.

Unlike other similar materials on the market, HI-MACS® is the only Solid Surface to enjoy official **European Technical Approval (ETA) for façades** – for Alpine White S728 colour – which was awarded by the European Organisation for Technical Approvals (EOTA).

During the manufacturing process, HI-MACS® is heated to very high temperatures by means of an advanced firing heat treatment. This procedure makes HI-MACS® different from other types of acrylic stone, giving it better uniformity and making it more resistant to shocks and UV rays.

Acrylic stone provides infinite possibilities for personalised designs and inspires professionals from all over the world. **Zaha Hadid, Jean Nouvel, Rafael Moneo, Karim Rashid** and **David Chipperfield**, among others, have completed fabulous projects using HI-MACS®, from kitchens to bathrooms, including decorative items, in hotels as well as in museums, shopping centres and on external façades.

HI-MACS® is available in around 100 different colours in various ranges; **Solids, Granite, Sand, Pearl & Quartz, Volcanics, Lucent, Eden, Galaxy** and **Marmo**, in different thicknesses of 3, 6, 9 and 12 mm, depending on the shade. HI-MACS® holds a number of international certifications with regard to the environment, hygiene and fire resistance, such as **ISO 9001** and **14001**, **Greenguard, NSF, LGA** and **IMO MED** certification (Modules B and D), among others.

HI-MACS® stands out for its excellent quality service, guaranteed by its **Quality Club** programme, consisting of a network of expert manufacturers and approved distributors across Europe. HI-MACS® offers the longest guarantee service on the market: 15 years.

For more information:

www.himacs.eu

HI-MACS® The New Generation

Inspired by Architecture

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