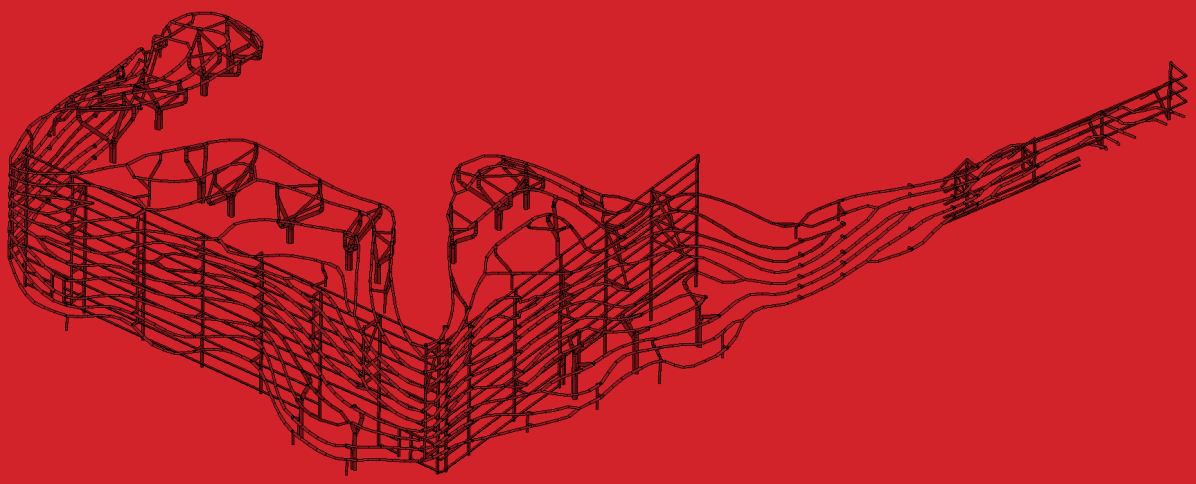
MATT CONSTRUCTION

Façade Construction: Petersen Automotive Museum

A CASE STUDY IN VIRTUAL CONSTRUCTION



“The drawings for the Petersen Automotive Museum were only printed because the city required it. The building and its groundbreaking façade were built to the virtual model.”



Want an internationally recognized façade of your own? Or perhaps just to integrate technology into your building process in the most useful way possible? Read on for a case study in virtual construction.

THE VISION

In the words of design architect Kohn Pederson Fox's Trent Tesch,

"It started with the vision of the Petersen board."

The board had a problem. People didn't know what treasures lurked inside of the former Japanese department store box that was the Petersen. KPF had the empathic desire to help the board achieve their goal of showcasing their artwork – of using the façade to announce the experience that awaited guests inside. And from its wildly creative beginnings, the design concept for the Petersen proceeded through the steps of technical execution to become tangible. Now it crowns the corner of Fairfax and Wilshire – a visual feast inviting enthusiasts and the merely beguiled to peek under the steel airstream of movement and power and enter the temple devoted to a pillar of Los Angeles' evolving culture: the automobile.



How do you hold your own as a part of the cultural conversation when you share a street corner with LACMA, Los Angeles' keeper of the cultural flame and arguably the last word in high culture in Southern California? You're a car museum. First, it helps to be in Los Angeles, where the diverse tastes of the city break open the conversation on what is culturally significant. And second, it helps that passion for the automobile transcends socio-economic boundaries. But really, you acknowledge that your collection is deserving of a better space. A space that is distinct, unique, spectacular. A façade on par with the sculpture housed within.

Communication will be a theme throughout this story, starting with the communication between the client and the architect.

If you're the client, you'll want to verbalize clear ideas.

Use descriptors of what you are trying to achieve to someone who can interpret them in a visual way. Think about the result you are trying to achieve and describe it.

The board of the Petersen told KPF that they wanted an image that was global. That resonated not only in Los Angeles, but in Europe and with potential donors all over the world. To tap into the idea of a car that was universal. They wanted curves. And above all they wanted *fast*.

THE DESIGN

From there KPF embarked on their creative process.

Architecture has context.

It is on a site. It doesn't move. Trent explains how KPF started with the history of Los Angeles and the notion of the car in LA. How the car was specifically involved in the urban formation of Los Angeles – a city that lacks relative density, that has multiple centers, that sprawls.



The Petersen Automotive Museum prior to 2015

The Petersen anchors one end of Museum Mile at the intersection of Wilshire and Fairfax, home to the first left-turn traffic light in the world. Here the car culture is significant, and the architecture is not driven by pedestrians, it is driven by cars. Here it is at times outlandish: We have cantilevered wings on gas stations so you can see the spectacle at 35 mph. This idea has its roots in the Googie style of the 50s and 60s.

KPF brought that context to what was universal in the language of cars:

Swooping lines, movement. And if you want fast, then it has to be red.

In the digital design process, one can take three to four initial designs and evolve them into a final. Ideas get modeled, then rendered, comments get made, the team iterates. This was the process that KPF went through until they arrived at something that resonated with the board.

But this process was far from linear. The architect wasn't working in a vacuum; the architect wasn't working alone. Very early in the process, Trent called Tony, and Tony called MATT.

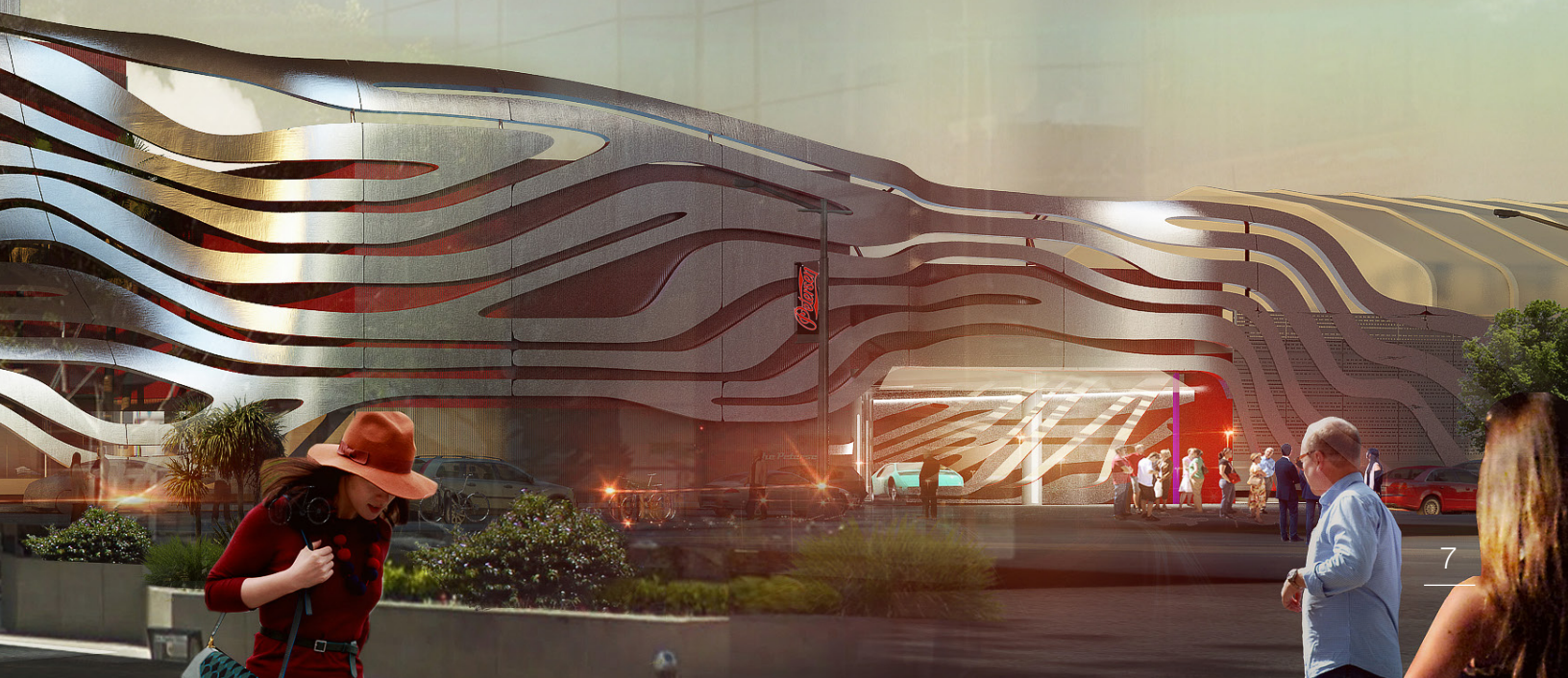


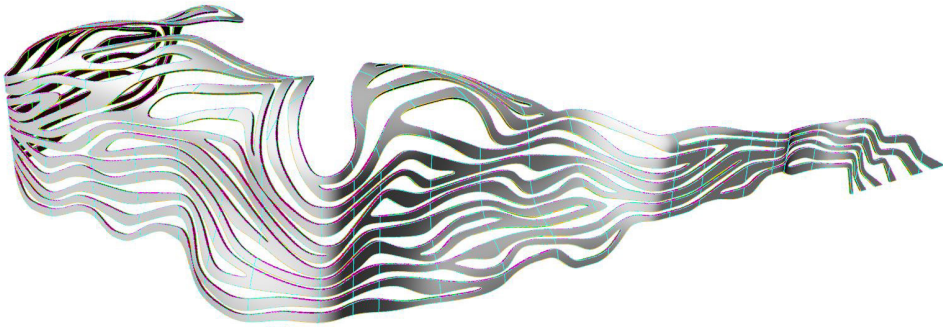
THE PLAYERS AND THE INITIAL TOOLS

That would be Tony Birchler, VP of Engineering/Sales at Zahner, and MATT Construction. Zahner, the world leader in fabricating unique metal façades, would help develop a means for fabricating the design. Birchler recognized quickly that they needed a partner experienced in solving complex constructability problems. Zahner called MATT and invited the general contractor to join the design process and weigh in on if/how the design could be built.

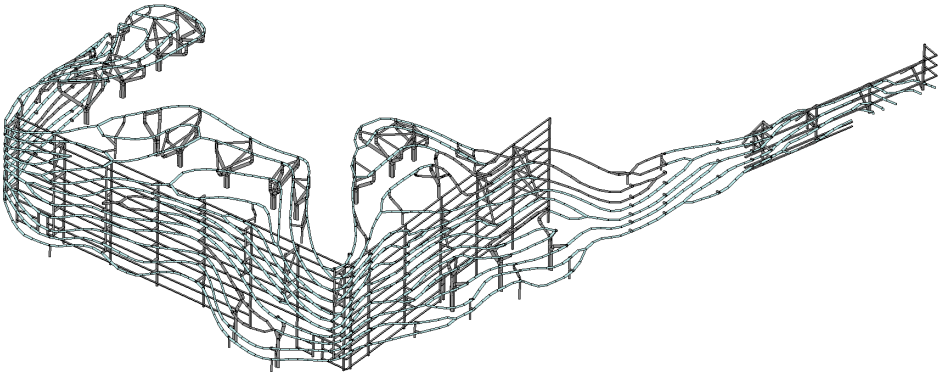
"Creative expression is a fundamental human need."

Steve Matt, *Chairman and CEO, MATT Construction*

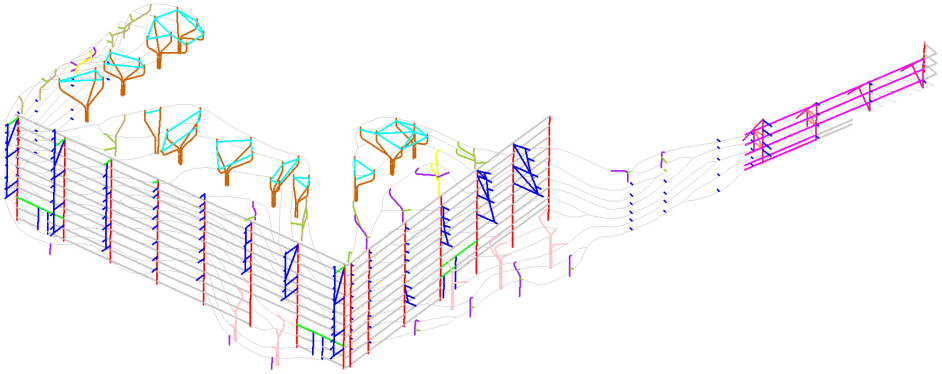




In construction, BIM (Building Information Modeling) done right is done in an agile environment.



Design cycles are short and involve client feedback in every step of the process.



Key players in the execution chain are weighing in along the way to provide creative consultants with good information about what can be built, what it will cost.

KPF generated the first model in Rhino, a 3D modeling program suited to mapping curved surfaces. They then compressed and distributed it via New Forma, a project file management software.

At KPF, the process innovations revolved around scripting the models so that when the architects needed to make changes, such as modifying a moment connection due to a constructability issue, they were able to quickly take the model and modify it in a way that was seamless and effortless, and then share it with the engineers and the building team so that everybody could use it as a point of reference. Distribution via New Forma allowed version tracking so that no information was lost.

THE ENGINEERING AND THE PROCESS

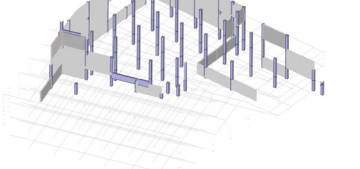
The full preconstruction team at the table included House & Robertson, architects of record, Zahner's partner-in-crime Wallace Engineering Structural Consultants, and Saiful Bouquet, structural engineers of record for the project. Doug Robertson's team at House & Robertson traded the Rhino model back and forth with KPF. KPF controlled the aesthetics of the Rhino geometry. House & Robertson checked it against code, lending their insight to facilitate city approval.

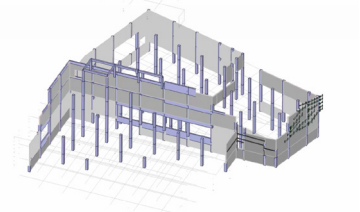
As preconstruction was happening within and without the building, structural engineer Tom Bouquet had the responsibility for the harmony of the overall structure. With the Rhino model of the ribbons, the engineers were able to see the weight, balance and geometric center of each ribbon.

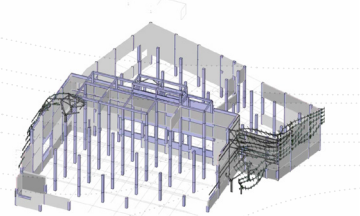
This collaboration in Rhino enabled the architects to sculpt the north and west façades and place the load at points where the structure could resist, and it could be transferred back to where columns intersected with structural concrete. It enabled the team to solve technical load problems on the roof and at ground level with trees and shrubs – ribbon support structures resting on horizontal surfaces – that looked sculptural and did not compromise the design vision.

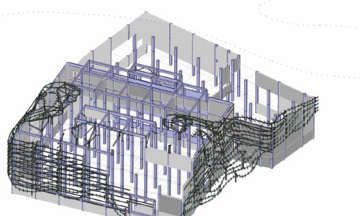
It did not start out quite so seamless. In the early stages of the process, Saiful Bouquet was collaborating with the ribbon engineers at Wallace. Wallace was handling the challenge of how to engineer the ribbons and Saiful Bouquet was handling the challenge of making the façade play nice with the building structure, while simultaneously designing a voluntary seismic strengthening of the building.

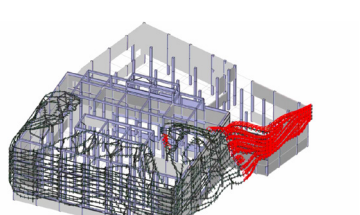
Multiple collaborators with different platforms created inefficiencies. Saiful Bouquet worked in design and drafting software AutoCad and structural analysis and design software ETABS. At the outset, Saiful Bouquet would receive the normal reactions for each element from Wallace – 600 pages worth. Saiful Bouquet would then apply the reactions to their own structure and test the movement of the building, changing the way the ribbons were supported so that the stresses flowed to other supports when necessary. This feedback loop took two to three weeks.

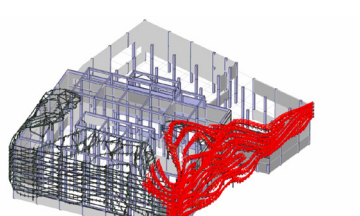


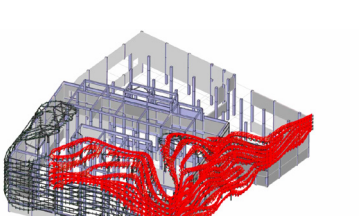


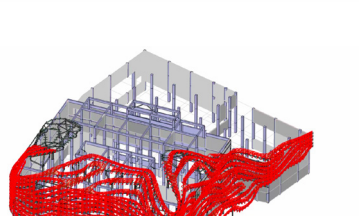


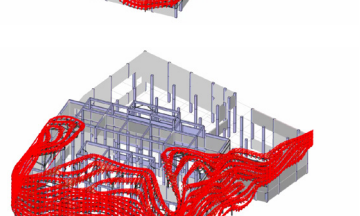








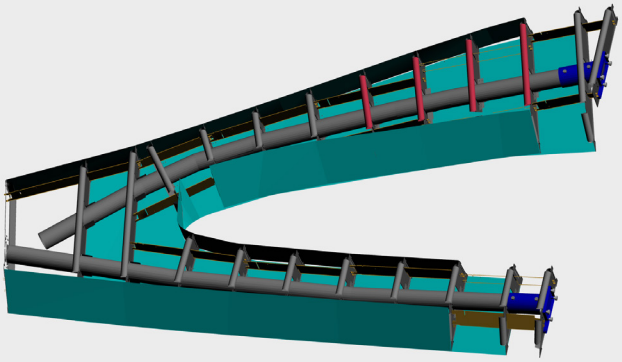


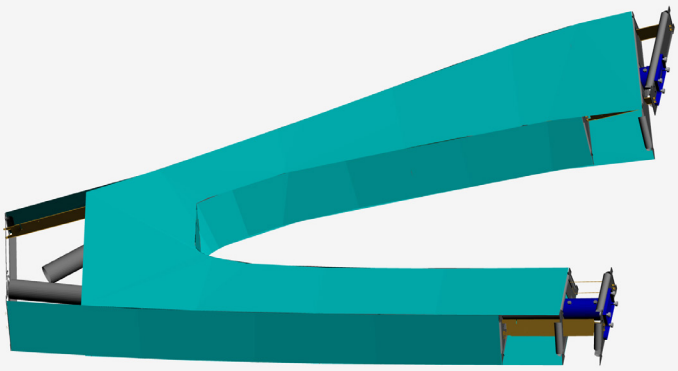


Tom and his team recognized that they had an opportunity to optimize the process and make the execution run more smoothly. In the interest of the process and the product, they invested in additional software, and rebuilt the entire structural model of the building in RISA3D so that they could bring Wallace's RISA model of the ribbons and trees in and work off the same model. This way they could not only put thermal loads on the entire structure and combine them with seismic stresses to see how the building would behave, but also significantly shorten the feedback loop.

There were some important reasons for aligning on software. The team needed to make sure the materials and the building had the correct stiffness. That the trees were at the correct point in space to both carry the load of the ribbons and transfer it to the structure.

The engineers tested gravity, wind, seismic and thermal reactions for the ribbons to the building, as well as effects of building movements on the ribbons, trees, bushes and outriggers. Tom and his team also worked closely with Wallace to detail connections of the ribbons to allow for construction tolerance.





Another challenge was figuring out how to connect the façade to the parking structure. As the museum and the parking structure are separate buildings that move differently in both earthquakes and heat, the engineers used the RISA3D model to test the idea of expansion joints in the ribbons – would telescoping pipes encased in ribbon cladding perform safely in a seismic event? The team learned that they needed a steel truss structure on the parking lot to grab the ribbons at a height of 20 feet.

Aligning on software and using the virtual model to work through these solutions in preconstruction allowed the solutions to be incorporated into the schedule and budget early enough to keep the project on track.



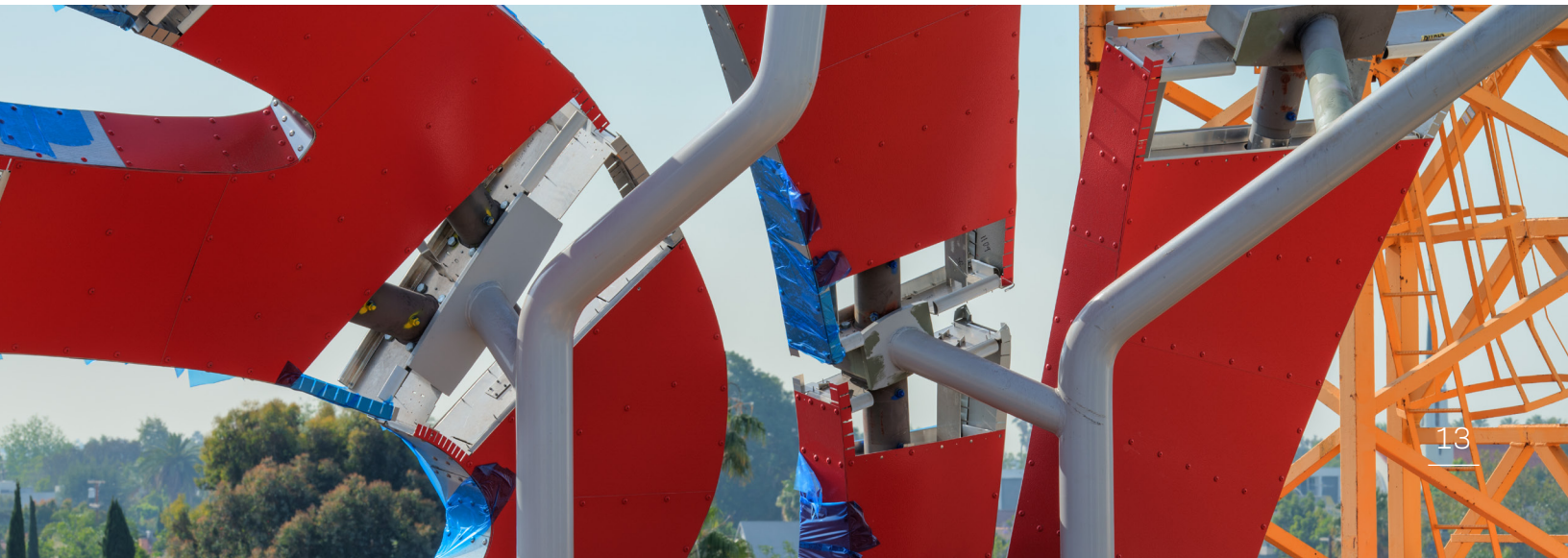




Back at Wallace Engineering, principal Steve Huey and the engineering team were working with the architects to decide:

What is possible?

There is a balance between making sure a building performs well in a seismic event and making sure it is *perceived* to perform well in a seismic event. A building can move in an earthquake such that there is no structural damage, but to someone watching it, or standing in it, too much movement, though safe, is disturbing. However, being too overconservative with stiffness places a strain on the budget.







The team used trees and smaller shrubs to transfer the loads of the ribbons to the structure. In an iterative process with the architects, Wallace worked to add bars to the trees and shrubs to interconnect them and allow them to move in sync and stiffen up the structure.

This enabled the architectural sculpture on the north and west façades to load at points where the structure could resist it. The load was transferred via the trees to where the columns intersected with concrete, allowing a safe intersection of the façade with the building in a way that gave continuity to the sculptural design all the way through the practical consideration of the attachments.

This design solution would perhaps not have been achieved in such an elegant way without the whole team collaborating in the virtual environment.

Wallace was also working on the geometry. All the ribbons were unique. They were more different than alike. Though for the most part not simultaneously, they curved in two directions in space. Connecting all this geometry to an existing building was challenging. In the field, everything had to line up. The sequencing of the load as each piece was added had to be thought through to account for deflection. Wallace had to make sure there was enough flex in the connections so that the pieces would come together well. (Being a Missouri company, they didn't want to be off by inches like the St. Louis Arch.)


United Rentals
S-85
BIGGE



Connecting all this geometry to an existing building was challenging. In the field, everything had to line up.

As no ribbon was square to another or to the wall, the connections had to rotate to be planar. The spines of the ribbons had to contain slip joints – a pipe within a pipe – to allow for adjustments at the connections and to enable the plates to come together. The virtual model allowed the team to refine the façade connections during preconstruction, minimizing the amount of modification required in the field, and contributing to cost and schedule certainty.



THE PATH TO SUCCESS

So what are Steve Huey's words of wisdom to those who want an outlandish façade? You can't wait and get the contractor or any other key player involved after the fact. You can't let the designer complete the design in a vacuum and then put it out for competitive bid.

To have success, you have to have all key team members at the table for the whole process.



Here are two examples of why:

1

Zahner was modeling the façade's ribbons in CATIA, a design, manufacturing and engineering platform. The ribbons would go straight from Zahner's CATIA model to machining, so Zahner had to refine this translation to the plant in the design phase. They determined that it would not be cost effective to employ a custom tooling die to fabricate the ribbon sheeting, and thus stretching the metal could not be a part of the manufacturing process. Not stretching the metal dictated that no single panel could ever be curved in more than one dimension at a time. Therefore, Zahner put the design through a rationalizing process to make the ribbon panel surfaces developable.

Using Grasshopper, a graphical algorithm editor within Rhino to script the ribbons' parametric curves, Zahner worked with KPF to design the ribbons such that the sheeting could be installed on the ribbons like tiling and would not need to be stretched on a press. Though some of the ribbons do indeed have a slight dual curvature, they are within the tolerance that the aluminum can curve without edge buckling. For those few pieces that could not be sufficiently rationalized, craftspeople hand-formed small sections of the panels to complete the design.

2

The client and the architect envisioned the ribbons extending to curve up over the roof of the Petersen. Therefore, trees on the roof would have to support the load of the ribbons. However, in many places where trees needed to be, there was no column in the building below to transfer the load. The roof had no capacity for the load, and due to MEP constraints, also no room for a beam.

The MATT team suggested an upturned beam partly above and partly below the roof. They drilled holes in the roof and used u-shaped bars to build a composite beam with shotcrete to support the load being transferred through the trees. This idea allowed the project to move forward with design integrity and the desires of the client and architect intact.

Without having all the key consultants and subcontractors on board early in the design process, this type of collaboration and solution-finding would not have been possible. Since the Petersen had assembled the team early, they facilitated creative, cost-effective construction solutions to support their design vision.



Additionally, assumptions and solutions can be different between the existing-building engineer and the façade engineer. The loads that each are assuming need to match the façade being made. If there is any discrepancy there, and you've got enough people on board early enough – general contractor, key subcontractors, engineers – you've got a team that can make your project cohesive and cost-effective.

You can then solve those discrepancies by engaging the whole team to look for ways to get the same effect with the façade and lower the cost. Or lower the stress on the structure.

If you don't have the key players contributing early, you could face big hiccups late. If there is a disconnect between the façade and the building structure, and the structure is already done, then you are faced with having to rethink or modify the façade, and possibly compromising your design vision or inflating your budget.

THE MODEL

This team not only got the price and the schedule right, but the building of the virtual model. It was accurate – it had to be. Once the design was established in RHINO, the geometry was handed off to Zahner, who controlled the working model. Starting with surveying to answer the question, "Where is the actual building?" Zahner worked in tight collaboration with the architects and MATT.

Regardless of software program, everyone used the same background data so there were no lost assumptions. For example, the existing building was being pared back to a structural box to support the structural frame of the façade. The red rain screen would then be clad over top and attached to the box canopy. Everyone knew exactly how much weight was coming off the building with

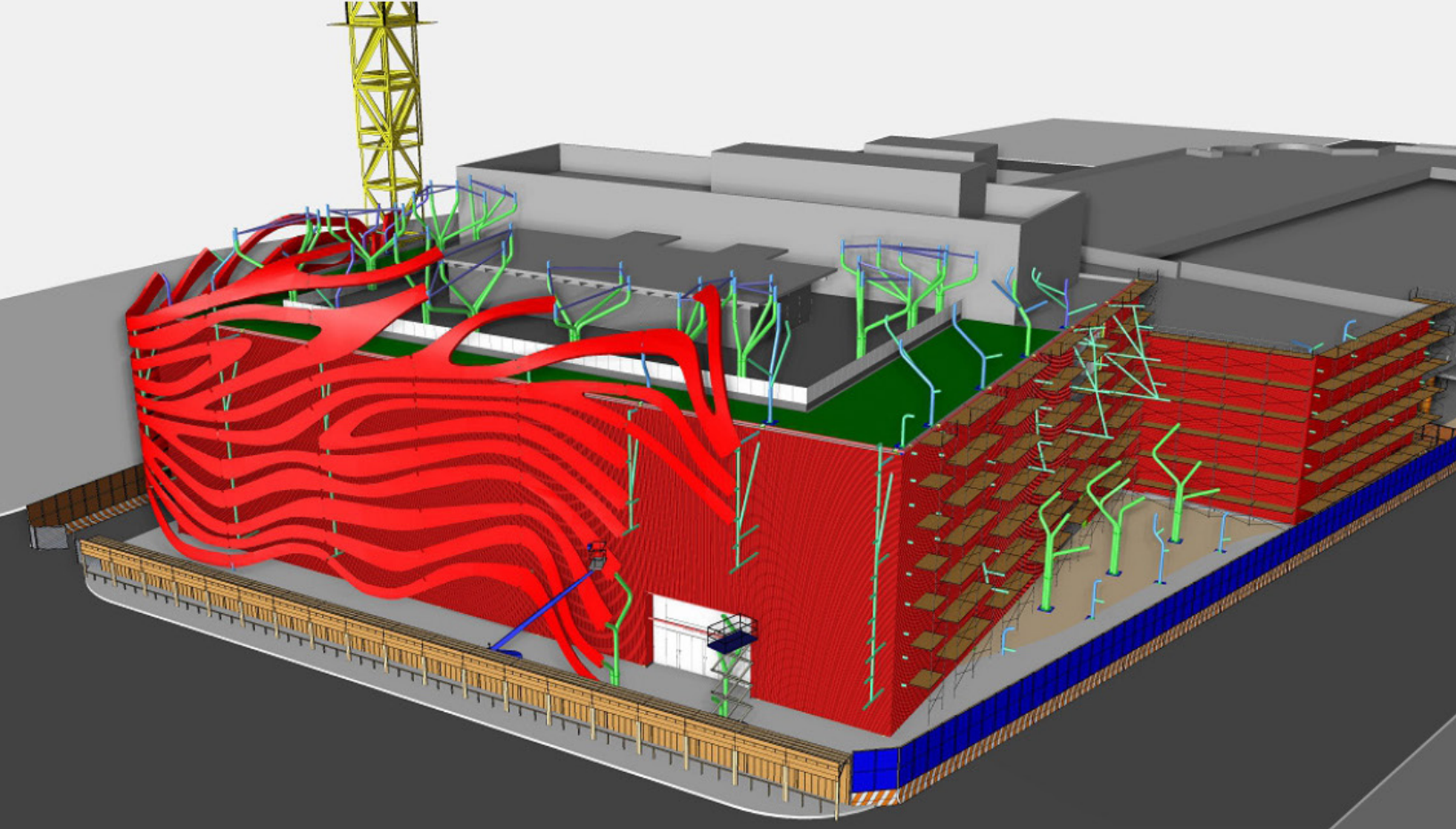
the demo of the existing concrete façade, and how much weight was going back on with the new design.

And everybody knew it in advance. Each element was planned and checked, planned and checked. In this agile BIM environment, if at any point it was determined that something couldn't be built, this allowed for an iteration in design in real time.

For example, the model allowed for tweaks to the locations of the trees and shrubs to support the façade, and the caissons under them, until the loads were completely dialed in. This was critical in preconstruction as the actual construction schedule was less than a year, and there was no room for delays once in the field.

With everyone on the same model, the owner avoided the disaster of having a design that didn't work, and elements that didn't fit together.

The team worked through how to design ribbon panels and moment connections flexible enough to fasten together in the field. They determined how to let those connections translate, rotate, level and plumb, and in some cases where the existing structure's wall had been constructed right to the property line, to be flush with the existing structure.



Another crucial component was using the model for scheduling.

With SYNCHRO Scheduler, MATT Construction expanded the model to 4D to script out the scheduling, allowing the team to determine how to access different areas and answer logistics questions like, “Can the crane reach this portion? Will it be able to deliver a ribbon here?”

During preconstruction and once in the field, MATT was coordinating all the moving parts and moving the whole process forward. The Petersen is located at the border of Los Angeles and Beverly Hills at an intersection that was concurrently the site of a Metro expansion project. Not only was it crucial to coordinate the team so that there was no overlapping scope, but it was critical to coordinate with all the relevant government entities.

The streets at the corner of one of the busiest access arteries into Hollywood were almost entirely plated due to the utility relocation work going on at the time. MATT worked closely with LA Metro and the DOT to achieve the level of coordination need to maintain pedestrian access.

This is where the animated 4D model became intrinsic to the success of the project. In preconstruction, the 4D model spelled out street and sidewalk closures, and access restrictions to the parking garage, allowing the Petersen to communicate with its neighbors about what was to come. It helped communicate how the team was going to demo parts of an existing building with people on the sidewalk under it.

The model helped set expectations for international donors, so that when donors in Italy and other parts of Europe made the trip back to see the progress, they understood what they were going to see on a particular date and where it fit into the process.

It was a benchmark for cost management. Using a 4D model communicated precise activity and expectations by date. The model showed subcontractors, in a much clearer way than bid notes, a complicated installation sequence – how two months of scaffolding was going to come down to drop the steel and then go back up – allowing them to price and plan their staffing much more accurately.

The 4D schedule also defined the sequencing. It allowed for the team to coordinate the attachment of the ribbons to the building shell and the trees with the fabrication schedule.





Once the design was complete, and each unique ribbon shape was known, Zahner modeled out how to fit all the pieces on to the least number of 8’ x 40’ flatbed trucks for transport from Kansas City to LA, and then fabricated the ribbons in the order that they would load the trucks. From the 4D model, they knew the way MATT was planning to build the façade, and once in LA, the ribbons were laid down in that order so that they only needed to be picked once – saving crane time and thus time to the overall schedule.

THE RESULT AND THE TAKEAWAY

Fifteen months of planning and less than a year of construction to transform an uninspiring concrete box into an internationally recognized symbol of Southern California culture. That level of collaboration takes work. It is not easy. On a team full of passion and talent there are strong heads and strong beliefs.

And everyone brings their own past experiences to the table. Building the trust to handle the inevitable differing viewpoints and getting on the same team takes time. It takes repeated demonstration of the key players’ respect for the team, of capability. Of a drive for excellence, not just a drive for profit.


It also takes an
unwavering commitment
to a win-win mindset.

Creating an environment where everything is in service to the project paves the way to common ground and focuses the team on solving issues for the client and the job. The team earned one another's respect when they watched each other do the right thing for the right reasons. When they saw others working hard, it made it easier for them to work hard too.

Not having to be in a position of scarcity helped matters. Why is this important? Well if you're the client, not only can you be shrewd about the team you put together, but you can set them up for success by matching the scope and desires of your project with the budget available. As risk decreases, people relax. Having the mindset that quality is a worthwhile investment and setting the table with a reasonable amount of resources allows your team to focus on creativity and execution. It shows respect for the work that your team is doing.

Lastly, not only does pulling the right team together early set your project up for success, it sets you up to enjoy the experience. Tackling the big problems requires a thirst for challenge and people who are game to dig in to the details. When you have a team willing to roll up their sleeves and solve problems together, the process is fun.

Architecture makes a difference. People are drawn to exciting architecture.

What would you tell a client that wants a statement façade?

Tom Bouquet
Founding Principal, Saiful Bouquet

Keep it light. Especially with a vintage building. Otherwise it will be impossible without a whole-scale mandatory seismic upgrade. One way to handle the mass balance is to demo part of the existing building to subtract mass before you add it back with the new façade. In the case of the Petersen building, this demo also whittled the structure away from its property lines, allowing room for deep sculpting of the façade.

The team also demolished a lot of heavy, brittle masonry material that eliminated seismic hazards while making room for the new façades. In all, over 777,000 pounds of new material was added, but over 1,200,000 pounds was removed.

The Petersen Automotive Museum, now an international icon, came in on-budget and on-schedule.

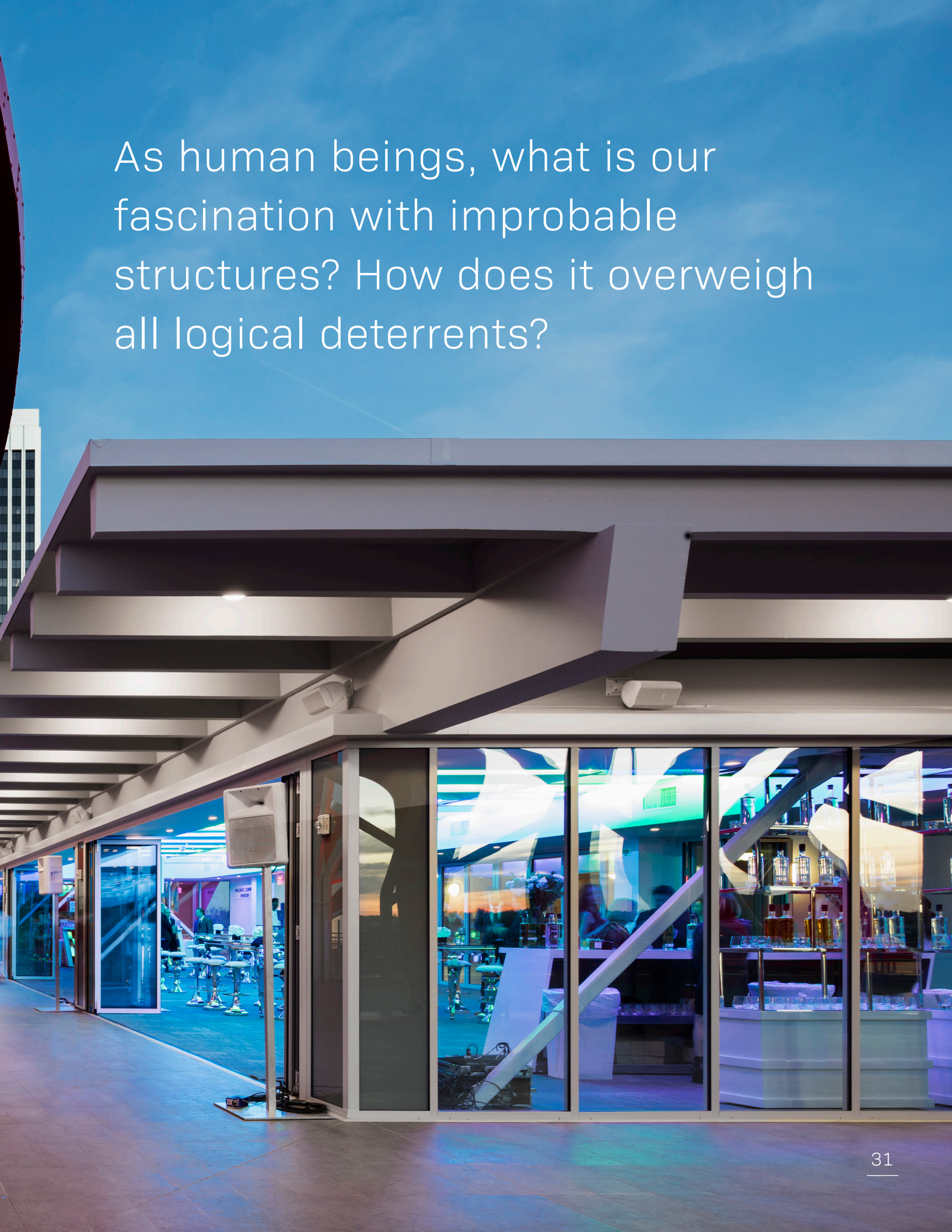


Since the renovation, museum attendance has increased six-fold per year. The car collection inside has not changed.





As human beings, what is our fascination with improbable structures? How does it overweigh all logical deterrents?



“

Trent Tesch,
Design Principal, KPF

It starts with the notion of being special. Museums represent our deepest cultural relationships with each other. All things worth living for are embodied in painting, sound, sculpture.

Museums are places where we come together to witness cultural moments in history. To review them and talk about their impacts on us. Museums stand apart. Each aspiration is unique and distinct. They say something about the exhibits – and therefore the cultural moments – inside through their exteriors.

Look at mega-tall buildings. There’s no economic reason for them to be built. It’s about leaving that physical landmark.

“

Steve Huey
Principal, Wallace Engineering

There’s no rational reason. Just emotional, spiritual reasons. It gives you an opportunity to think about things that are possible. You think, I don’t know how someone imagined those shapes, how someone built those shapes. How do they do that? There’s everyday architecture and there’s transformative architecture. You can stand on a roof, or in a place you’ve never been in before and think, wow. Like the cathedrals of Europe, you’re walking into the void. The form, the shape transports you out of your everyday reality.

It gives you time for more than that. It’s an uplifting of the human spirit. It transports you to the realm of what’s possible.



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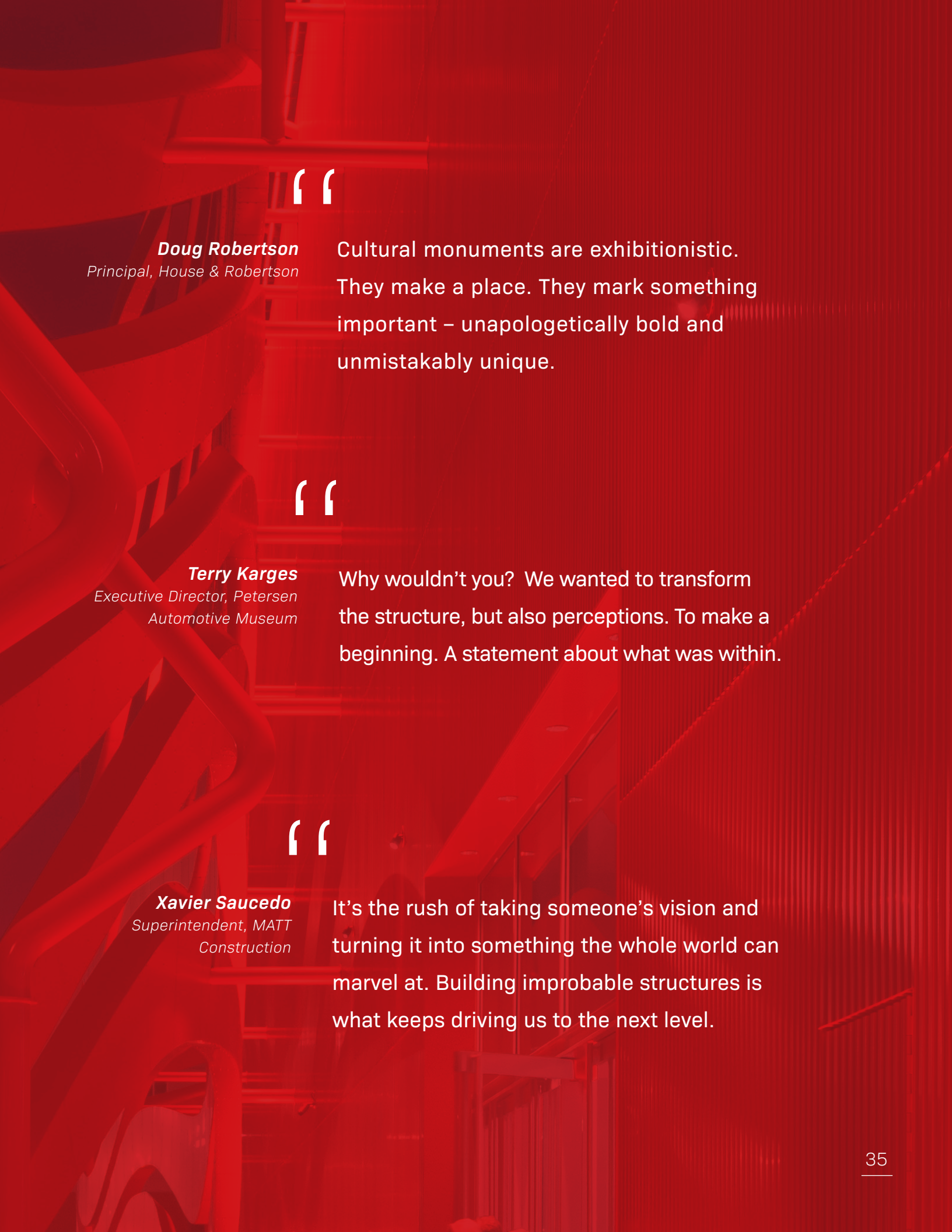
Tony Birchler
VP Engineering/Sales, Zahner

Think about Italy, and the light there. It’s something exotic, different than you’re used to. It changes – it’s not the same over and over. It captures the imagination because you haven’t seen it before. And then you hear the back story – the inspiration from air streams passing over a car in a wind tunnel test. And then you think about the material. That’s the challenge for us.

“

Peter Mullin
Chairman of the Board, Petersen Automotive Museum

What sculptural figures do to the unconscious brain is an interesting question. The beauty of the right radius, the right curve intuitively speaks to one’s inner voice. Seeing no right angles is unexpected. And extremely satisfying to the brain. Seeing something fantastical, dreamlike allows the creative side of the mind to race forward.



“

Doug Robertson
Principal, House & Robertson

Cultural monuments are exhibitionistic. They make a place. They mark something important – unapologetically bold and unmistakably unique.

“

Terry Karges
Executive Director, Petersen Automotive Museum

Why wouldn’t you? We wanted to transform the structure, but also perceptions. To make a beginning. A statement about what was within.

“

Xavier Saucedo
Superintendent, MATT Construction

It’s the rush of taking someone’s vision and turning it into something the whole world can marvel at. Building improbable structures is what keeps driving us to the next level.

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