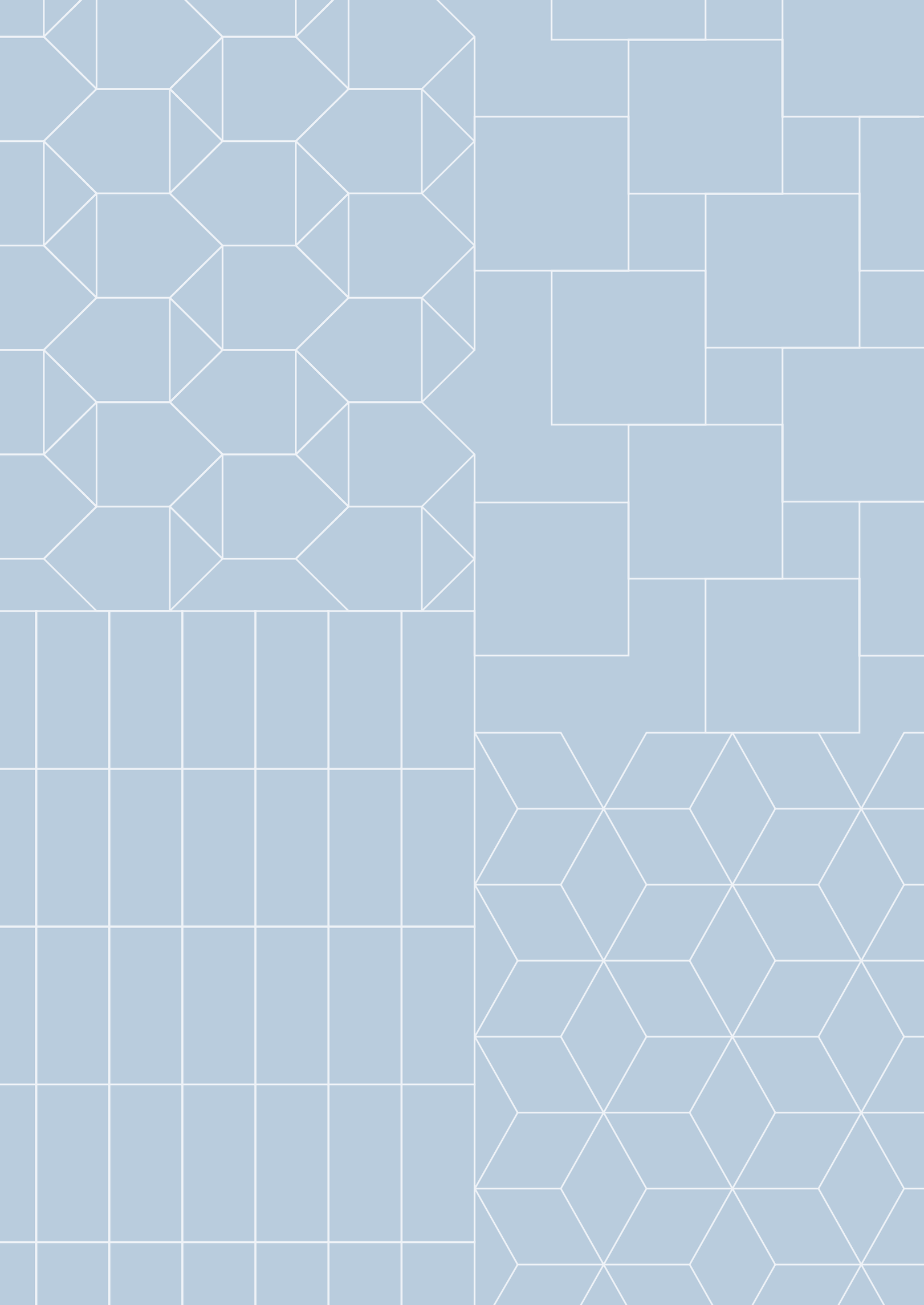
PATHWAYS

Unlocking Innovation

and Charleston East

at Bay View



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100 Bay View

Foreword

John Igoe
Director, Real Estate District Development, Google

To build a once-in-a-generation building, it takes vision, leadership, and the ability to suspend disbelief to see what's possible. With Bay View and Charleston East, Google put together the best of local and global talent to deliver new buildings that thoughtfully expand our Silicon Valley presence while delivering on our values as a company: respecting the user (including Googlers, local citizens, and visitors) so that they all have a great experience.

I joined the Google team in May 2011, having already been engaged on the Bay View project during my time at Sares Regis Group. It was early days for both Charleston East and Bay View, and I helped bring together the teams to make the work possible. We thought a lot about how to create a culture that would inspire and align all of us. After selecting BIG and Heatherwick Studio as our design architects, we then assembled an amazing project team of landscape architects, structural engineers, interior designers, sustainability consultants, project managers, and, of course, general contractors to make the vision a reality.

These two projects mark the starting point for Google deciding to build its own spaces and places. Up until that time, we did what most large companies do: buy or lease buildings. Often that meant we had to invest a lot in revamping them to meet Google's needs. Our leaders had aspirations about everything from healthy materials to indoor air quality, biophilic design, sustainable performance, and general design excellence. What if we started with our own vision to make brand-new buildings – buildings that could evolve with Google?

Our global design team developed core values for Charleston East and Bay View's design, anchored around innovation, nature, and community. We wanted buildings that inspired a strong sense of belonging and connection that would demonstrate

Opposite page: Bay View and Charleston East were made possible by amazing people from hundreds of vendor partners. Heatherwick Studio architect Christopher McAnneny captured friendly faces at the project sites.

Opening spreads: A series of images by Iwan Baan show different views of Bay View from the sky and surrounding landscape.

Previous spread: A view of one of the entrances to Bay View 100 from the central courtyard, shot by Iwan Baan.

how thinking differently can take green building methods to a scale never done before. As with everything at Google, a focus on the user was paramount, and with these buildings, we designed for Googlers (our employees), local citizens, and visitors for years to come.

The result is a set of human-centered and sustainable buildings that have many "firsts" between them. At Bay View, we have the largest geothermal installation in North America, and a water-positive campus that shows what's possible for Bay Area ecological restoration. At Charleston East, we have a building with one of the most comprehensive installations of healthy materials, that also serves to foster community with an activated plaza and event space.

Another incredible thing about Charleston East and Bay View are the longspan canopies. Covered in dragonscale solar skin, the roofs are a structural engineering marvel. We affectionately refer to them as a "cathedral of work." It's a place where great minds are going to meet to do great projects. The way the natural light comes in throughout the day on the upper floor, where everyone is working together, is magical. And the lower floor is designed for community and gathering.

These buildings are some of the largest in the world to pursue LEED Platinum v4 certification as well as Living Building Challenge Petal certification.

Now we're taking what we've learned and applying it across Google's developments from the ground up – everything from water reuse, solar panel siding, and biophilic design to cross-laminated timber (CLT) construction and design performance.

Of course, none of this would be possible without the people behind the work. Over the last decade, we were able to assemble an impeccable team of design, engineering, and construction professionals.

Opposite page: Google is exceedingly grateful to the thousands of contractors who helped bring Bay View and Charleston East to life.

Following spread, clockwise from top left: Construction workers navigate the various steps of installing the dragonscale roof system: the base track and halter system; installation of the metal deck on the tube net structure; clerestory glazing units lifted into place; standing seam on the primary drainage layer.

At Charleston East, PMA and Devcon helped to bring the project to life and delivered an incredible product. At Bay View, Sares Regis and Whiting-Turner did an amazing job from start to finish. On both developments, Turner & Townsend did an impeccable job as our accountant and controls experts, while Adamson Associates served as the architect of record. And throughout the process, Google was able to build out a real estate development team to embark on our next chapter of building sustainable, inclusive spaces.

The deep collaboration for these projects involved not only the project team, but our community partners and many others at NASA, the City of Mountain View, the City of Sunnyvale, the County of Santa Clara, and state and federal agencies. A huge thank you to all of the agencies that supported our vision.

As I look back at all of the effort that went into these two remarkable buildings, it's clear to me that the two keys to success are relationships and communication between people. No single organization can take on this scale of effort alone. There must be a unified focus and a common goal among many partners. All of the teams and individuals must be aligned on values and goals. By working together and sharing what we know to scale solutions, we aimed to transform what was possible and reinforce innovation, nature, and community.

In all of this, we're inspired to share what we've learned. As you explore this book – the conversations, context, and solutions – we hope you learn something new about the power of innovative thinking and the many pathways to solving problems.


SAFETY
WORKS
HERE


SKATE
ANTIHERO
BOARDS


WT
WHITING-TURNER
Andrew Miller


DAVID


Google


PHOTOS

Setting the Stage: Google's Legacy of Human-Centered Workplaces

For decades, we at Google have poked and prodded at the notion of work: who does it, where it happens, and how we can encircle it within an environment where everyone has the tools they need to be successful. When we moved into our Silicon Valley campus back in 2003, just five years after our founding, we wanted to shake up the stuffy, rigid workplace environment that had become the norm for corporate headquarters. We designed airy, open offices with bright colors and playful elements, where Googlers were invited to bring their dogs, collaborate in the open, and enjoy amenities that made the workday not just bearable, but enjoyable.

From the beginning, we've wholeheartedly believed that the success of our company rests in the hands of our employees. Thus, designing our spaces for our employees' health, happiness, and collective well-being is one of the most important things we can do.

Since Google's founding in 1998, we've relentlessly pursued this ethos of putting the user first. It's a human-centric mindset that applies to how we approach our products and services, but also extends to how we design our physical spaces and places. In the workplace, this translates into environments that are not only healthy and highly sustainable, but also high-performing and adaptable to an unknown future. Over the last two decades, we've trained our sights on creating inclusive, welcoming environments that bring people together, prioritizing human connection by making sure everyone has access to healthy, productive environments.

We know this user-first commitment can't just be on the surface level. It must be embedded in our core values in a way that puts people first, but also considers our place within a global community. In 2007, we were the first major company to become carbon neutral, and in 2017 were the first to match our operations with

Opposite page: Early examples of how Google's brand and sense of joy played out in office interiors, often with a focus on local culture, evoking surprise, and bringing people together.

100% renewable energy. Our founders held a deep-seated belief in the power of the built environment to contribute to human and environmental well-being, and as the years passed, we've learned even more about the pivotal role our buildings and workplaces play in the enduring health of our planet. For us, a healthy workplace is not just one where people thrive, but where the environment and the natural world around us can thrive, too.

The latest additions to our Silicon Valley campus, Bay View and Charleston East, represent our effort to model the next generation of work, both for ourselves and those around us. Across these two projects with four buildings, 1.7 million square feet, and 60 acres, we've created a prototype for the workplace of the future: flexible places designed to inspire innovation, big ideas, and community.

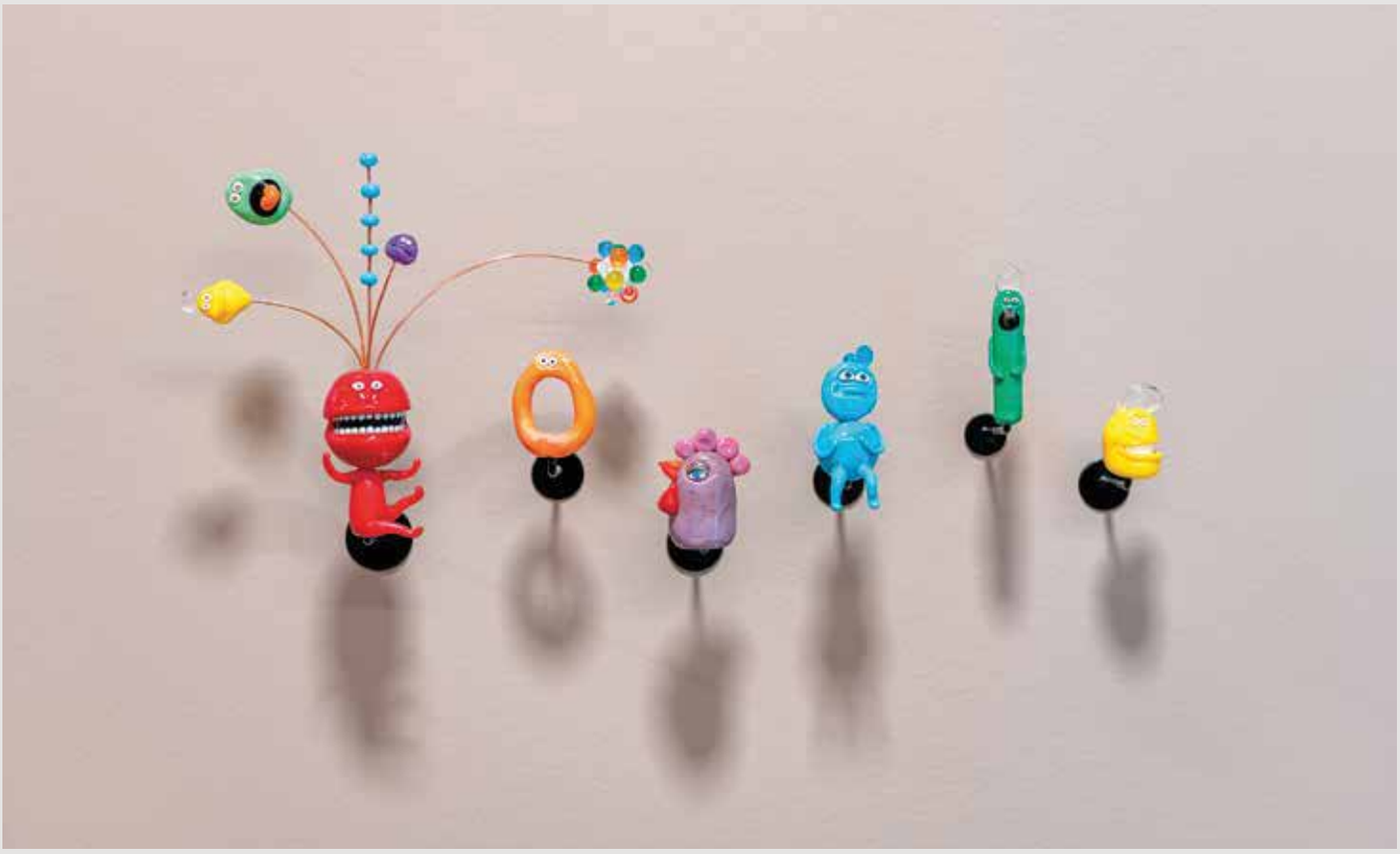
There's only one thing we know for certain about the future of work: It's impossible to know what it will look like twenty years, ten years, or even five years from now. With Bay View and Charleston East, we wondered: How can we build places that will grow with us? And how can we design buildings that will last? We wanted to chart a path for healthier, more sustainable buildings that use less and give more, both to the environment and to the communities around them. These projects represent the first time we led the concept and construction of our own major campuses. It was an opportunity to rethink the very idea of an office building, and in doing so rethink what is possible for the larger building industry.

In traditional offices, there is an unstated rule, perpetuated for some time, that views and sunlight are rare. Most office buildings are not built for everyone. We decided to challenge that, thinking deeply about health and wellness in the space and how we could promote it for everyone, both inside and around the building.

We also wanted to shake up assumptions around form and function for high-performing buildings in a way that could be scalable to the industry as a whole. We wondered: Why can't building technologies that generate renewable energy be efficient *and* beautiful? Can we harness the qualities of the ground below to heat

Opposite page: Elements of locale and joy incorporated in Google's global offices.

Below: Reinterpretation of the Google logo as playful art in one of our offices.



Above: A colorful lounge shows an example of spaces Google designs for casual collisions.

Opposite page: A new structure was built for Google within the adaptive reuse of the Spruce Goose Hangar in Playa Vista, California.

Following spread: A view of the central courtyard and staircase at Bay View 100, otherwise known as the "mothership stairs" due to its saucer-like landings.

and cool our buildings at a massive scale? How can we ensure that materials in our buildings are healthy and safe? And, as is becoming increasingly important today: How can our spaces be flexible and inclusive enough to meet the dynamic needs of our teams today, tomorrow, and for years to come?

We know there are many diverse pathways to address these and the multitude of issues that arise when we ask the biggest question of all: How can our buildings contribute to a carbon-free future? Bay View and Charleston East are part of our biggest ambition yet: By 2030, we aim to be the first major company to operate on carbon-free energy, 24 hours a day, seven days a week. We know the answers to the biggest questions often arise through collaboration and co-creation, which is why we offer this book as one template toward building a more regenerative future. We want to share our thought processes, our solutions, and our lessons learned, all in hopes that others will continue the path we began with these buildings and develop it even further.

And it's not just about creating more sustainable buildings. As we take a long-term view to future developments, we want to implement solutions that will benefit Google and our communities for years to come. It's about creating regenerative, healthy, and inclusive places where people and the environment can thrive together. Today, as we create new spaces and places, we know how important it is to balance ambitious climate solutions with social infrastructure strategies that deepen community well-being for everyone.

Google has never been a conventional company. Over the years, we've done our best to hold onto our joyful spirit and healthy disregard for the impossible, keeping the search for better answers at the core of everything we do. We might not know at the outset what shape the solutions will take – just like we didn't anticipate the sweeping, longspan, tent-like forms of Bay View and Charleston East's buildings when we began – but we've learned the journey to getting there is the most exciting part. The winding, meandering pathway is where we uncover the small discoveries that lead to big innovations, with the power to benefit people and the planet on a larger scale. Ours is just one path to a more sustainable future. What will yours be?

CONVERSATIONS

The latest addition to Google's Silicon Valley campus is a story of radical collaboration. The unconventional design challenges posed by these highly sustainable buildings demanded novel ways of thinking, requiring people to suspend disbelief and come together for an open conversation about how to solve the most pressing environmental and human-centered design concerns. We believe that to innovate solutions to the growing challenges facing our planet and our communities, we need exactly this type of interdisciplinary collaboration.

What follows are conversations with 16 of the core team members who helped bring Bay View and Charleston East to life. These idiosyncratic and honest accounts of the process behind the design and construction of the new buildings are revealing, sometimes surprising, and often heartening. Most importantly, they demonstrate the power of co-creation, where a synthesis of qualitative and quantitative responses was needed in order to make the impossible, possible.

Building to Google's Values

David Radcliffe
VP REWS & GSRS

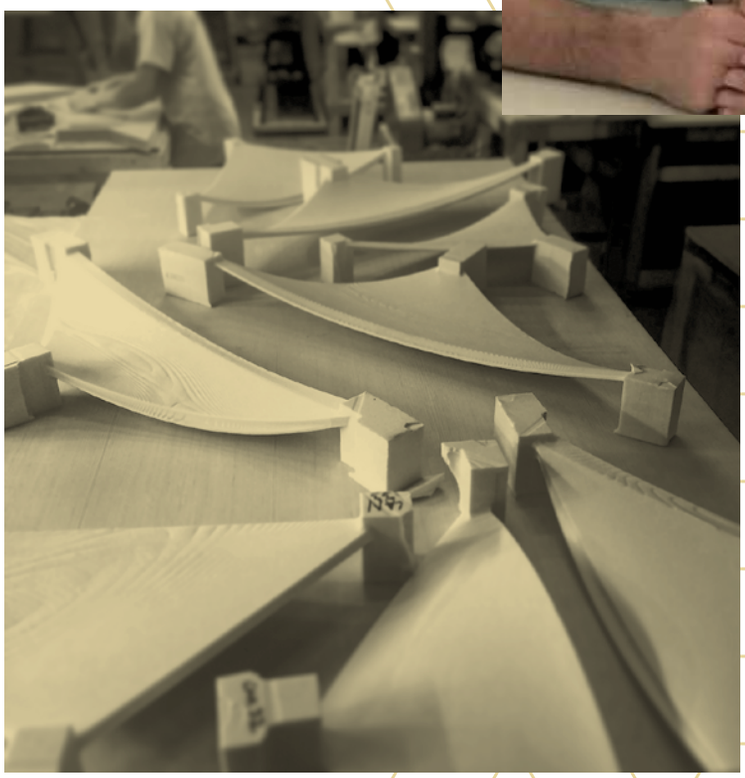
"Buildings are often designed from the outside in, where the form or shape of a building becomes the driving force. For us, it was about designing from the inside out, prioritizing the human experience inside."

Opposite page, top to bottom: Google's David Radcliffe and architect Thomas Heatherwick studying an early model of the Landings office development in Mountain View; a close-up of a model of the longspan canopy; a model showcases the second floor "tables" concept for team neighborhoods.

In your own words, can you describe what you do at Google?
As vice president of real estate and workplace services (REWS) and global security and resilience services (GSRS), I'm responsible for managing all aspects of Google's global real estate portfolio, industry-leading employee services, and physical security services that enable the company to thrive. My organization works with our businesses to create the optimal environments where our 150,000-plus employees, located in over 170 cities spanning more than 60 countries, can do their best work, every day.

What were the goals you set out to address with Bay View and Charleston East?
Google has always been an innovation company, and we've found that by bringing our employees together, even if only for short periods of time, they are best able to quickly organize and solve complex problems together. Our goal for these projects was to eliminate as many of the historic barriers and frictions that a traditional built environment can introduce to an employee's workday. We also knew the way work is done would transform greatly over the life of our buildings, so we needed to create the most flexible structure imaginable. When we set out on the projects, we had no idea that the COVID-19 pandemic would accelerate this transformation for how we work. Very simply, creating flexibility for our business and eliminating friction in workflows were the driving principles for how we thought about our workplaces, and how we approached Bay View and Charleston East.

We decided that if we were going to construct new buildings, we should do it right. That meant not assuming that decisions made by developers before us were the right decisions for the outcomes we wanted. We paused, took a step back, and asked ourselves, "What would we build if we could start with a clean slate?"

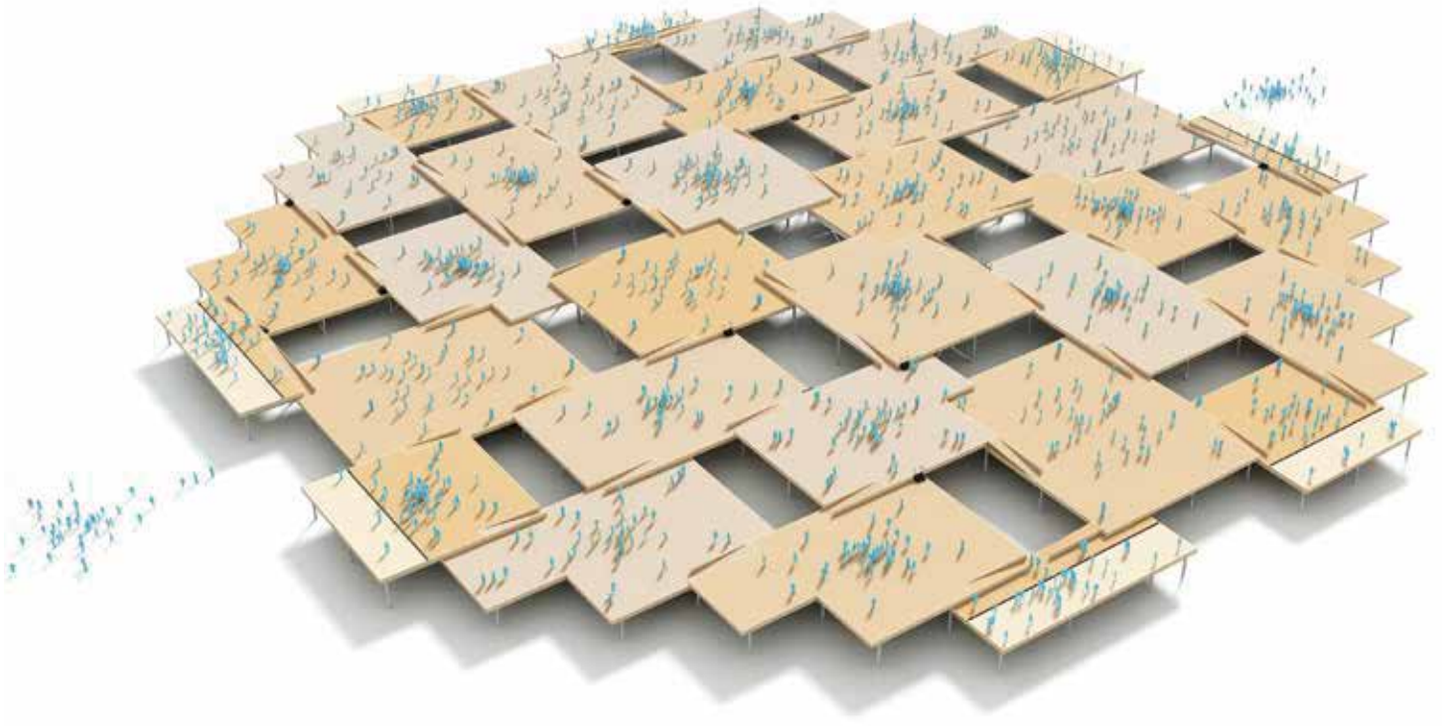


Ultimately, we started with the Googler. We investigated a few key things: why they come to the office, what they need from the office, what they need from their teammates, and what they need from the company. And we built out from there. We wondered how we could make a building that embodied equity, recognizing that every individual needed the same opportunities for heads-down focus space, inspiring spaces to disconnect, places to connect with their teammates, and access to daylight and views.

How did that focus align with existing approaches to workplace design in the spaces Google previously occupied?
As we started to look at normal buildings, we recognized there were a bunch of frictions introduced in typical buildings that made achieving those things very difficult. We heard it firsthand from Googlers in existing buildings we occupy. Over and over, our staff told us it was difficult to get work done because they were distracted by noises and activity happening around them. At the same time, they told us it was tough to find places for spontaneous collaboration because conference rooms were constantly full. We also knew from our research that people who reside within the same floor typically have many more shared experiences.

It sounds like Bay View and Charleston East began from a place of research.
Yes. We stepped back and asked, "How can we reorganize the workplace to get all the benefits from our years of teams-based research?" That's when the notion began to emerge of an incredibly large-span building where we could organize people all under one roof, on one plane. We realized that what people really need are their teams, and what teams really need are communities. The larger organization works best when there aren't barriers fragmenting teams. But we knew that if we approached this in the conventional way, it would be a depressing sea of cubicles. So the question became about how to organize the space and get the best of both worlds: collaborative and heads-down space.

Buildings are often designed from the outside in, where the form or shape of a building becomes the driving force. For us, it was about designing from the inside out, prioritizing the human experience inside. We thought about the volumes of these buildings as similar to the mass of a theater, where a great open span allows



Below: Visualization of the interior "human scale" second floor. The large floorplate is broken down into a series of smaller "tables" separated by courtyards and connected via ramps that gradually elevate as one moves to the center of the building.

Above: A model of the second floor showcasing reconfigurable office partitions, collaboration zones, wayfinding structures, and courtyard elements.

for people, props, and stages to be moved around inside. At the same time, we challenged ourselves to think deeply about the building process and sustainability.

How were you defining "sustainability"?
Sustainability is one of our core values at Google, so it doesn't matter if we are making sandwiches or making buildings, we want to do it in the most sustainable way possible. In terms of how we are framing it, I once heard this very simple definition of sustainability that has stuck with me ever since: "Enough for everyone, forever."

It's such a simple definition, but it really starts to get at questions around the footprint of our buildings. For me, when you challenge yourself to build things that are lighter, you're using less resources, creating less waste, and soon it becomes an almost self-fulfilling prophecy.

What were some specific ways you challenged yourselves on this project to make more sustainable buildings?
First and foremost, we recognized we needed a much more integrated process than typical construction projects, where trades and disciplines are serialized and fragmented. From the start, it was always about making sure we had highly integrated teams.

Second, it was about challenging building materials, and what we wanted those materials to achieve. The key example for me is the dragonscale roof on the buildings. People have been putting solar panels on roofs for a long time, but once the building starts to take an unconventional shape or you talk about different kinds of facades, the efficiency of solar starts to diminish. We challenged that, and wondered if there were other ways to think about both the angle of the facades and the material itself. And we've come up with a beautiful solution, which hopefully changes the mindset of what can be done to cover an entire building with PV panels in a way that makes it productive 365 days a year.

Above, clockwise from left: The construction team from Schuff Steel prepares for a "pick" of the "smile truss" at Bay View; the team at Bay View sets the first "smile trusses," as seen from the tower crane above; Google's John Igoe, Chris Alwan, David Radcliffe, and Ian McGillivray review plans for the next phase of construction.

From the start, were you hoping Bay View and Charleston East would change the way people outside of Google thought about buildings?
Yes, but it's certainly not something we thought would be an endgame. These places were never meant to be reference points. Rather, they are starting points. We've always thought of these buildings as a journey. Early on, we framed them as living buildings. They are pilots, and as such they need to be incredibly flexible.

We've had the good fortune of purchasing a number of buildings over the years that have turned out to be phenomenal workhorses, for lack of a better word. In each case, what makes those buildings so transformative is their ability to go through an adaptive reuse process. It was important to us to look back in history and recognize that many of the best structures, in our experience, had all the basic tenets of flexibility, whereas the current generation of commercial office buildings tends to be incredibly inflexible and can only be used for one thing. We wanted to pivot back to some of the great structures of the past, while also creating a framework, a materials language, and an ecological approach that could help push the industry forward.

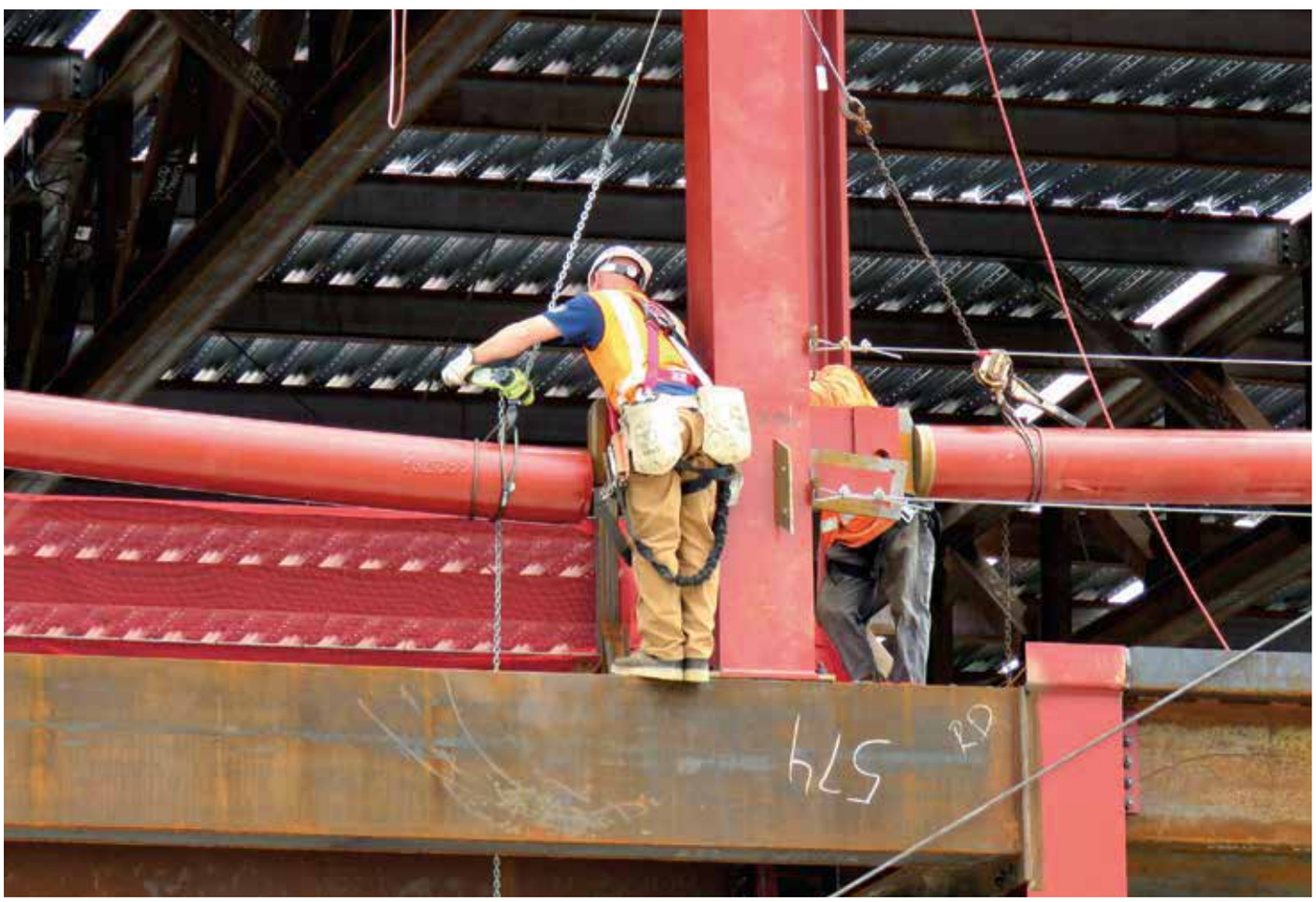
Now that the buildings are complete, what do you hope they convey about Google and its values?
I think they speak directly to the core values of Google, beginning with a focus on the user. From a building perspective, our users are Googlers, first and foremost. The buildings are welcoming and they sit within the larger community. In the example of Charleston East, we've created public amenities like a cafe, event and education space, and a public plaza with programming.

Lastly, it's about being highly flexible. When we began working on this project, we knew that the nature of work was going to change dramatically over the next decade, and our reliance on virtual collaboration would continue to increase. Sure enough, the pandemic rapidly accelerated that path. But as these buildings are opening, they are able to perform because they were designed to be incredibly flexible. They were built to give people very intentional, heads-down focus areas, and then at the same time allow them to pop out and have quick collaborations with folks, either in the open or in enclosed areas. They were designed for what we think is the prime reason to bring people together in buildings: create social connections, community, and a sense of belonging.

How does this project reflect the values of a post-pandemic workplace?
The way we started to design the interiors of these buildings pre-pandemic is certainly not the way we'll use them post-pandemic. But for us, the design was always about how quickly we can flex these interiors, reconstruct, and adapt them for new ways of working. For any workplace to be truly revolutionary, there needs to be a harmony between the virtual experience and the physical experience. If technology and the virtual experience are going to continue to advance at an accelerated pace, that means the physical environment must advance just as quickly. And I truly believe these buildings will be able to keep up.

It sounds like the journey for these buildings is just beginning.
I think of this project as a living laboratory that allows people to see how teams can come together at great scale, and still have the intimacy of a three- or four-person working unit. It's a blueprint for what it means to bring people back together in the workplace. It shows that buildings can continue to evolve and give you the best of both worlds: intimacy at the small scale, and connectivity at the community scale, which has so clearly become one of the prime functions of buildings moving forward.

Below: Construction workers assembling structural steel for the events center at Bay View.



Realizing Wild Ambitions

Bjarke Ingels
Founder & Creative Director, BIG
Co-Design Lead on Bay View & Charleston East

"Everyone on the team had to abandon their traditional sense of ownership in favor of a data-driven, meritocratic design process."

Opposite page, top to bottom: Early campus master planning studies envisioned a series of canopied structures connected by the "Green Loop," a sustainable infrastructure network throughout North Bayshore, Mountain View; the classic architect's "napkin sketch" scaled 10x to show ecology principles during early design meetings with Google; the BIG and Heatherwick teams visit Hangar One at Moffett Airfield in 2014. Flexible, longspan structures provided design inspiration from the beginning.

What was the initial client brief from Google?
Our job was to translate Google's dreams and visions of what a work environment and a building could be into reality. When Google originally engaged us in November 2013, we were asked to create a video explaining our design philosophy and addressing what we saw as the key challenges for Google in creating the next generation of work environments. I had previously been given a pair of Google Glass smart sunglasses, so we had Leon Rost, our partner in charge on the projects, chase me around New York and Copenhagen, visiting some of our projects.

We made it to the next step, and in May 2014 we received a brief that a team of designers, architects, engineers, and various consultants had assembled with the purpose of creating a holistic vision for the redevelopment of Google's land in North Bayshore. There was an idea that the company was going to add thousands of Googlers, and there was a new commitment to creating something akin to an urban master plan or a holistic vision for the whole area, rather than just a series of independent office buildings. This also meant thinking about the natural environment of the area, and how you move from one place to another.

The challenge from Google leadership was to focus not only on what was available in technology at that time, but what was *going to be* available in two, four, ten, and twenty years into the future. And if it wasn't available then, maybe it could be Google's job to invent it. Right from the start, there was an idea that when you take on big, relevant challenges to solve something for yourself, it might actually be applicable and scalable elsewhere.

Those are some lofty goals. What was your reaction to hearing that brief?
I remember my first meeting with Google's leadership, and Larry Page had this little stack of photovoltaic panels. They weren't inserted in glass, they were more like a

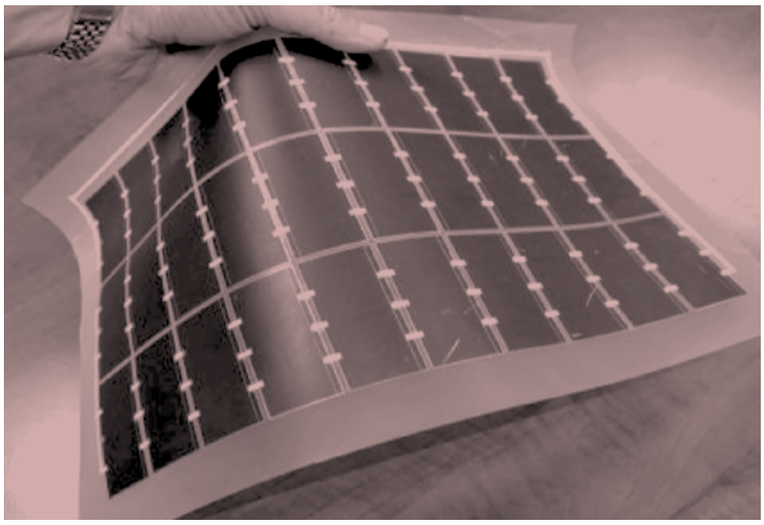
deck of cards. They could produce a substantial amount of power, and very clean. There was this excitement about completely re-imagining what a building could be. Especially in terms of its environmental performance. How could we make a building as light as possible, in every way?

We also realized that Google was going to potentially be constructing a lot of buildings over the next few decades. So there was a desire to make sure the first building was the best that we could possibly deliver. And then let's keep upgrading, so maybe we are working on things that aren't ready for the market yet, but that shouldn't stop us from starting to develop them now. It was incredible to be able to deploy meaningful resources for new things to happen, and to take wild ideas very, very seriously.

What do you mean by "wild ideas"?
It wasn't about being naïve, or not caring about the facts. No. The "wild ideas" were actually in caring deeply about the facts, and taking them very seriously. It was different from my typical role as a designer, which is to listen to a client and then, based on what we hear, try to get them to go a little bit beyond their comfort zone. Here, it was trying to get the client from the moon and maybe a little closer to Earth. It was like landing a spaceship, while also trying to elevate the typical building to new heights.

Below, top to bottom: Rendering of early North Bayshore campus plan concepts, envisioned as a series of glass tensile canopies with deployable shading and integrated photovoltaic technology; flexible, lightweight photovoltaic panels were an integral element of the glass canopies.

Center: Fabric deployable shading structure mocked up in the Google R+D Lab for the Built Environment. Many shading techniques and technologies were built and studied in-house early on.

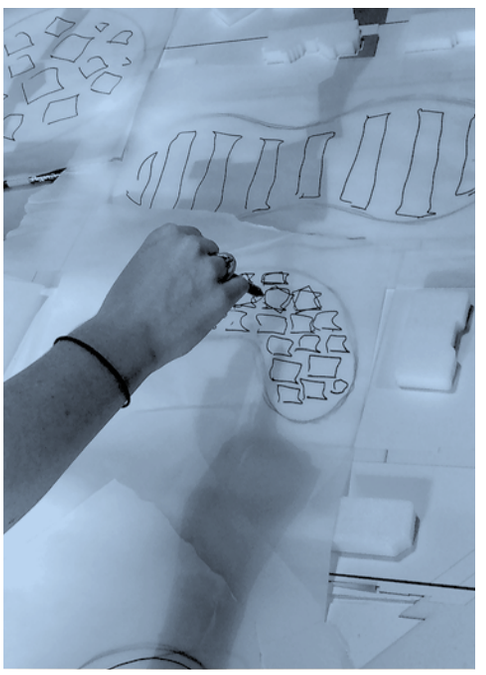


When did the conversation shift to focus on the buildings and less on larger creative concepts for the North Bayshore area?
As part of the larger vision work, we had developed an idea of the canopy as a minimal way of creating a conditioned environment that would feel a bit like outside, while being inside. And under that canopy, create a village of different ways of accommodating all the different workspaces. We began trying to make the first iteration of the idea around very light, tensile canopies that could encompass a very large conditioned area. At this point, the project went to the next phase on more solid ground.

There was an interesting dynamic at this point, and at many points through the project. There would often be oxymorons – where we worked with something as a concept that seemingly contradicted itself. For example, on one hand, Google's leadership was very interested in the idea of practically working outdoors. But on the other, they were also obsessed with air quality – especially folks at Google who are drawn to data-driven decision making, and were actually working with measuring the actual air quality. How do you combine the two?

As architects, I think we are probably on the more data-driven end of the spectrum. But of course, in collaborating with Google, that was taken to entirely new levels. One of the ways we approach decision making is testing different ideas by drawing

Below, top to bottom:
Architects Bjarke Ingels and Thomas Heatherwick working on early concepts for the campus plan; Thomas and Bjarke reviewing a glass sample with Patrick Pichette, Google's former CFO.



them up and modeling them. We're always trying to make the intuitive decisions more informed by fact. Again, that got taken to new extremes working with Google. I think we have never made as many options or studies of the various paths that a project could take, all so that we could make decisions not just based on gut feeling, but informed by hard numbers. During the early days, it felt like nothing short of space-age polymer was going to make the cut for that canopy concept. But once we began the process of making the first real buildings, we started to think differently.

How would you summarize this way of thinking and working that emerged with Google?
I like the term "pragmatic utopia." It's a nice oxymoron. Utopia means "no place," or a place or world so perfect it can't exist in reality. Pragmatism is about dealing with the world as it is, with reality and the limitations as they exist. To combine these two things is how you move the world forward.

How did this data-driven creative process affect the final building designs?
Even though we were working purely digitally for a while, it's the one-to-one material samples, the tactility and physicality of actual materials, that make a difference. We need to test things in full-scale, and make large physical models. These mock-ups are the most important way to ensure the quality of the actual construction of a building, and at the earliest, they usually come about during construction. Normally, even having them at all can be a luxury. So to be doing mock-ups at the concept phase, where we weren't even designing a single building yet, but simply talking about a typology of building, that was incredible. And we had a great ally in Michelle Kaufmann, who was leading the research and development effort at Google to crank out these mock-ups at a pace that matched the creative process.

I've never had the prototype, model, and mock-up capability that we had in our collaboration with Google. That meant we had a whole warehouse full of real-world samples of the ideas we were testing – things like glass, deployable shading devices, solar tiles. I think one of the greatest outcomes from that process was shifting from mechanical operables in the roof canopy, which was a large part of the first design, to something completely static. Instead of trying to react to the dynamic conditions of the sun, the design shifted to simply let in the amount of light that we needed, and then harvest the rest for electricity.

It was rare to see such a commitment to innovation and such an understanding of the fact that you can't just draw things up in theory and then see them for the first time on the building itself. You need to test it, because each time you do, you discover new things that will make the end result better. In a way, the more garbage you create in the design process, the less garbage you'll make in the real world.

Opposite page, clockwise from top right: Bjarke Ingels testing the walkability of the solar shingles while reviewing the clerestory glazing at Bay View; a prefabricated space frame system mocked up at Google's R+D Lab for the Built Environment; a conceptual model of the tensile canopies with open floorplates; Google's Michelle Kaufmann takes a selfie with BIG and Heatherwick teams as they help assemble a solar prototype in Mountain View.

How did that collaboration affect your personal practice outside of this specific project?
I love Google's general philosophy: Instead of waiting around for someone to ask you to address an issue, if you find a problem worth solving, then get going on it. Use whatever means are at your disposal right now to get the ball rolling. And once you do, you might be able to attract more resources or more collaborators to join you. That has been a fundamental mind shift for me, and many of the things we've done since then have been inspired by that idea.

What were those big issues or problems you were trying to solve on Bay View and Charleston East?
When we started, Google had already set the standard for a fun, engaging, playful work environment. And they wanted to reinvent that. At the same time, they wanted

to maintain their rebellious, startup, DIY mentality, even though they had reached a certain level of maturity and scale as a company. How could the workplace retain that feeling of energy and entrepreneurship from a startup mentality, and the intimacy of a small company, while also tackling the problems that sometimes necessitate thousands of people engaged in a meaningful way?

To address this duality, we became fascinated by two typologies. One was Building 20 at MIT, which is a three-story wooden structure built during World War II that, over the years, has been home to a disproportionate amount of Nobel Prize winners. The idea is that the informality of the building, combined with the fact that it is made of wood, meant that you could cut through walls and floors. It inspired the idea of having a hackable environment, rather than a perfectly made box, which is a finite product offering and the opposite of open source.

The other typology we looked at were the three large airship hangars on Moffett Airfield, which is adjacent to Bay View. We were all fascinated by the scale and generosity of this very, very large environment where you could do desk work, but you could also prototype stuff, and you could make structures within the structure. In that sense, it was about tackling the dilemma of providing the intimacy of a startup, but within something that is custom-made and designed to accommodate several thousand Googlers.

Another major source of inspiration was in exploring the idea of a 100-year building, which meant that it needed to be flexible enough to accommodate wherever Google may go in the future, from software to hardware and whatever else the world may throw at us. And in the process, we created an ideal workplace in that it is flexible enough to accommodate those types of changes in how we work.

You collaborated with Heatherwick Studio, and Google was also a major collaborator on the design from the start. How did that collaborative process benefit the design?
Google hired both Heatherwick and us, and they did the same thing on almost all of the other disciplines on the project, in that they hired two of the best they could

Below: Bjarke Ingels and Thomas Heatherwick take inspiration from a wooden space frame hangar at Moffett Federal Airfield.

“It’s about deploying at scale sensible, readily available technologies, and showing how they can be not only environmentally sustainable, but also economically sustainable and aesthetically beautiful.”

find: structural engineers, people with expertise in glass, environmental engineers. This meant everyone had to abandon their traditional sense of ownership in favor of a data-driven design process, which was a bit jarring at first. And actually, a lot of the very important design problems ended up being engineering challenges. For example, the canopy is a very pure structural exercise, where in many ways, the engineers were taking the lead in creating all of the different studies, and we were helping to visualize and give input. On other aspects of the project, someone else would necessarily have to take the lead and others would chip in. Ultimately, the decisions were meritocratic – based on the merits of the design option that performed best.

What do you hope the legacy of these buildings will be?
First of all, I think we succeeded in making a gorgeous building where the entire facade is either PV or glass. So, in a Google way of saying it, it harvests every single photon that hits the building, either by letting it in as daylight or converting it into power. With this project, we began to play with the idea of PV as a material, and now we are continuing that idea on other projects at BIG. Similar is the geothermal installation at Bay View, which is part foundation and part energy. We’re building our own headquarters now where we are using a similar technology.

It’s about deploying at scale all of these very sensible and readily available technologies, and showing how they can be not only environmentally sustainable, but also economically sustainable and aesthetically beautiful. I hope buildings like Bay View and Charleston East can help popularize, disseminate, and scale these types of ideas.

I think we will have succeeded if we’ve created an environment where people feel resourcefulness and creative self-reliance. The last thing we wanted to do was to create a polished mausoleum, or a standard corporate building, where no one dares do anything.

It’s also about what the buildings do for the landscape in which they sit. They are ultimately work environments, but they can create generous and enjoyable public spaces. At Bay View, all of the water from the buildings is cleaned in the landscape – the landscape is not only beautiful, but also performative. The buildings serve as good neighbors in that way. They elevate not just the urban environment or the work environment, but the whole ecosystem of the Bay in ways that are increasingly something a company with the scaling significance of Google should be doing. Here, Google is showing a way to do it.

Following spread: All three canopies at Bay View appear to overlap from this vantage point with the “G” signage in the foreground.

Human-Centered Placemaking

Thomas Heatherwick
Design Director, Heatherwick Studio
Co-Design Lead on Bay View & Charleston East

"Our sense is that change happens in the world through determination and perseverance. Rather than rushing us to a solution, we were given time and space to push ideas to their absolute limit."

Opposite page, top to bottom: The Google, BIG, and Heatherwick teams workshop together at Google's R+D Lab for the Built Environment; Leon Rost and Bjarke Ingels of BIG deep in conversation with Thomas Heatherwick; a preliminary rendering of Charleston East shows a glass dome with many layers of activity inside, reflecting the early intent to create a seamless connection with nature.

How did you begin your relationship with Google?
It started when I gave a TED Talk about ten years ago, and Michelle Kaufmann, who now leads Google's R+D Lab for the Built Environment, came and spoke to me afterward. She was excited by our human-centered approach to making places and our interest in human emotion as a function to design with and around.

What was the collaborative process with BIG like?
We threw ourselves into it and worked very hard as a joint team. We agreed that we would split the authorship and the responsibility 50-50. There are common interests that unite BIG and us, but we also have slightly different perspectives and experiences, so that meant there was sufficient curiosity to make the collaboration a healthy one. We felt there were things we could learn from each other, rather than simply duplicating efforts. Working with Google was also a collaboration because their leadership is very much about questioning everything and being interested in pushing the limits of what's possible.

What was your initial thinking about the design for these buildings?
The breakthrough for us was when we tried to understand the land around existing sites and the sprawling nature of individual buildings in this part of Mountain View. Each one has a tarmac tutu of cars around it. All of these existing buildings were the legacy of a few decades earlier, and it felt like they were taking and not giving. They didn't express the world we live in today and many of them didn't work.

We wondered if we could reassert the importance of an area being interesting for everyone, whether they worked for Google or not. That spirit felt appropriate, but we also knew that unlike other firms who are focused on one initiative or one drive, Google is very broad. They're pursuing so many different ideas. So much so

that, halfway through our project, they renamed themselves "Alphabet" to allow the company to cover a quantum of different initiatives, many of which are purely research-based or experimental.

How did Google's drive for experimentation impact the design?
It was exciting to be part of their effort to innovate and make change. In the design, we wanted to get more of that feeling of diversity, rather than a monoculture. On the surface, it might have been easy to interpret Google's ask as simply to build additional offices but we wondered how we could take that to the next scale for the organization and think more about the notion of the creative studio space. This felt particularly meaningful for an organization that prides itself on being engineering-driven rather than marketing-driven.

What design inspirations did you look at?
We were shown around the Moffett Federal Airfield, adjacent to the NASA Ames Research Center where Bay View is located. Here we saw three large airship hangars: vast, engineering-led spaces. That was a breakthrough for us – it was when we realized, do we really want to make offices that fix and calcify an organization? Or could we make something more flexible, in the same way that a hangar creates a place for everyone inside but is unlimiting because of its flexibility?

That was an exciting moment. We presented to Google's leadership and said, "We don't want to make you offices. How would you feel if we made you hangars instead?" We thought we could make the landscape even more biodiverse and lush and make flexible space that would allow us to make our own place within that protective shell. It was a lovely moment when the challenger, the person who tested us on every assumption we ever made, said: "Yes. Go ahead." That launched the exploration into how we could make a hangar-type structure with longspan canopies. It was about facilitating a flexible, internal urbanism that could be changed over time.

This protective shell also allowed us to rethink the building fabric – up until that point, we had only seen solar panels used as an optional addition to buildings but by creating these huge tent-like roofs, we could use this dragonscale skin of PVs to harvest the sun, with clerestory windows punctured through it to give the best daylight levels inside.

What was it like to work with a client like Google who is so committed to innovation?

Below, left to right: A view of Hangar One at Moffett Federal Airfield – one of the largest free-standing structures in the world, built in the 1930s to house naval airships; a rendering of Bay View's envelope design showcases the longspan structure with a series of "smile trusses" from column to column and lightweight "tube net" steel.

Above: A series of early studies examining various shell typologies and how they create and organize different forms of human-scale space within.

We were exploration partners. Our sense is that change happens in the world through determination and perseverance. Rather than rushing us to a solution, we were given time and space to push ideas to their absolute limit. We were able to explore the limits of materials, engineering, transportation, mechanical systems – every aspect of the project was an open question mark, with no fixed assumptions.

It became clear to us early on that Google's leadership was not used to being taken seriously by architectural experts. Instead, architects had treated the leadership as if they didn't get it, saying, "No, that's not how it works." This sort of limiting attitude was not breeding the conversations that would lead to innovation. It would shut down ideas or try to justify a repetition of an existing approach, which is not the point of Google. I think we and BIG were the first team who gave oxygen to those conversations.

There were moments when exploring the edges entailed knowing there were factories that could make something to bring innovation but it might take 10 or 15 years for building codes to catch up and allow us to actually execute that idea. As a designer of a project like this, you want to go to sleep at night feeling there's nothing more we could have done. It was that exhaustive pursuit of excellence, which we always aspire to but don't always get the chance to fully execute. Here, we had the chance to work with an organization that was as ambitious as we were and have the best experts in the world as our collaborators.

That is reflected in what the buildings became, but it's important to say there was not a carte blanche with the checkbook. We had to argue for the value of every-

Above: Two joggers cruise past Bay View on the adjacent trail.

thing we proposed, so there was an intensive process of analyzing value in every single bit of the project.

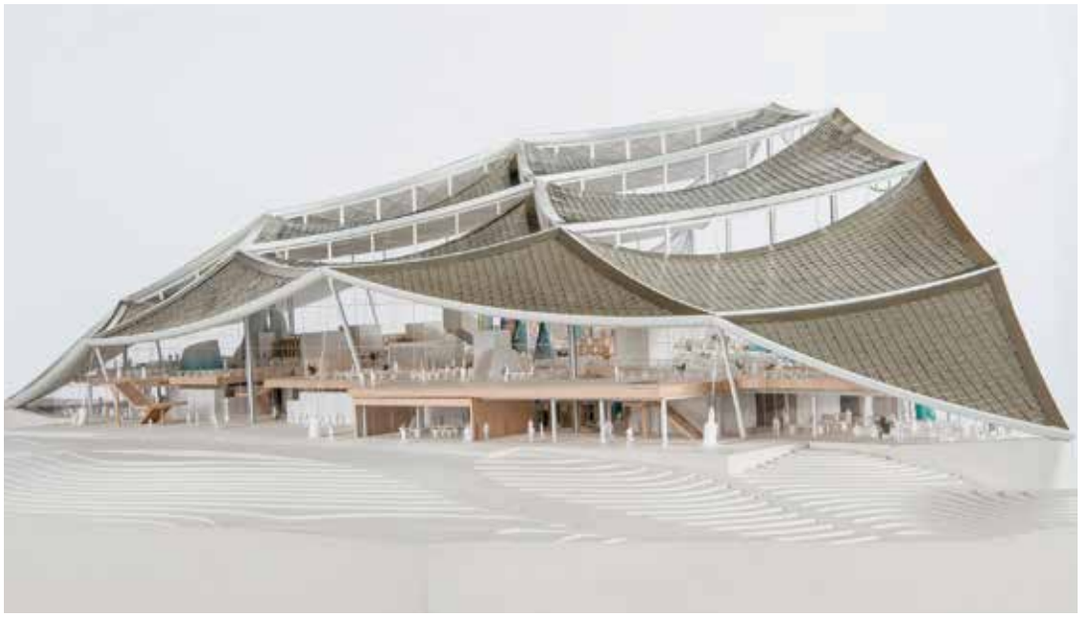
It was about getting to an essence of where there is real value, and where there isn't. These are not environments that need to sell anything to anyone. They're about optimizing the workspace for Googlers to do their best work.

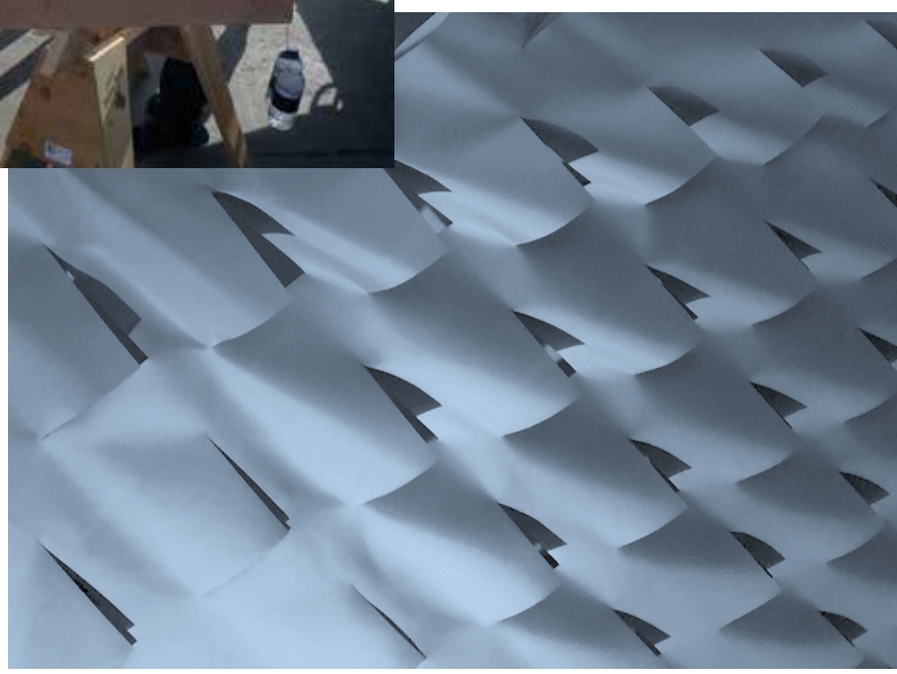
How did you conceptualize "optimization" in the workspace?
The notions of efficiency in the workspace are, in many ways, outdated. It's not the obvious rationality that's been used in the past, where you are optimizing widths of walkways and desks. I think the COVID-19 crisis has validated even more the approach we took on this project.

Our approach centered on the notion that the emotional engagement of one team with one another is what matters. It's beyond conventional notions of office efficiency. It's more than that. It's about triggering your team's imagination and facilitating a sense of open-mindedness. Our ability to question assumptions and cliché – this is the essence of our humanity and this is what AI will have to struggle increasingly hard to compete with.

The idea of the "office" has been stuck for a long time. Yes, people have done different aesthetic treatments on the outside of boxes of offices, but there hasn't been a fundamental questioning of the workplace at this scale for quite a long time. We felt very lucky to have the chance to work toward the possibility of showing a new way that people can work together.

What can this project teach us about the future of the workplace?
On the social side, the question is: How can you bring people together rather than isolate? How do you allow a focused sense of one another without the over-adoration of the open plan? There were a number of explorations like this that came together, but they are all rooted in a single question: How can you make the office more human?





This page, top to bottom: An early model showing a cross section of the exterior; the team, including Bjarke Ingels, Patrick Pichette, and Thomas Heatherwick, worked on an early prototype at the R+D Lab of a possible sun shading system with a few moving parts. The early prototype used fabric, duct tape, and a broom to try out the idea quickly and later led to a more developed "handkerchief" idea; at the R+D Lab, many form factors were studied to inspire the design.

“We thought we could make the landscape even more biodiverse and lush and make flexible space that would allow us to make our own place within that protective shell.”

Opposite page, top to bottom: A view of Bay View from the adjacent Stevens Creek Trail; Charleston East as seen through the local ecology.

It seems an extraordinary coincidence, yet so valid, that the pandemic has busted through the paradigm of the worker going to work: they must be there by an exact time, they can’t be trusted working at home. The games, the “watercooler moments,” the staff party, the briefcase, the tie. These are all bizarre things that the world of work has normalized. The pandemic offered a break in the repetition of that habituality.

For Google, we were designing something intended to question all of that, even before COVID-19. To translate that into making a more profound piece of town – it’s a powerful alternative. These are spaces that create a whole different atmosphere of work, or whatever we call those endeavors. These are places of multiple endeavors.

What do you hope this project’s legacy will be?
When I began work on this project, it was fascinating to see the physical reality of a valley that has changed the world, but Silicon Valley itself hasn’t changed much at all. We felt there was a role for a new place here where someone, one day, might say they found a bit of beauty.

I’m also very proud that the buildings are generous. Generous not just to the people inside, but generous in the way they are softened. They encompass significant space, but they’re not imposing. They touch the ground softly.

Research shows that buildings constructed since WWII are twice as likely to be demolished as pre-WWII buildings. So as designers, we have to ask ourselves, “What are we doing?” There’s a phenomenal amount of waste involved in demolition and rebuilding. We also know that if something has a quality about it and is actually loved, then you’ll want to adapt it and adjust it as the decades go by, rather than destroy it. For me, sustainability is partly about the technical dimensions of environmental performance. It’s also about creating places that people cherish.

The Importance of Making Things

Michelle Kaufmann
Director, Google R+D for the Built Environment

"We realized we needed to make things in order to talk through our architectural ideas. There's nothing like touching and feeling a physical built thing to help advance understanding."

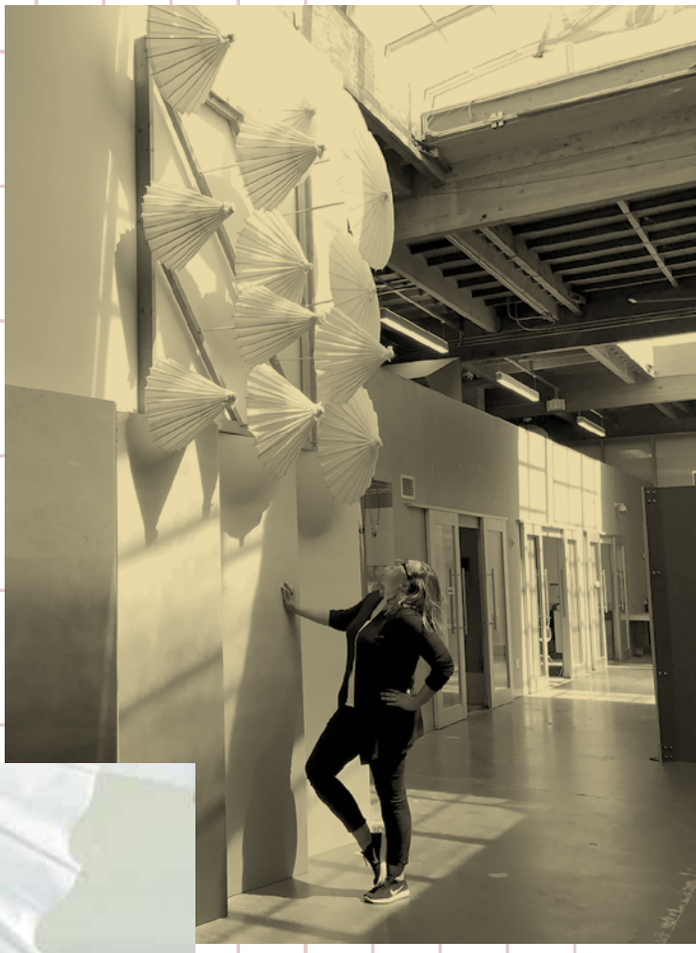
Opposite page, top to bottom: A mock-up of a building-integrated photovoltaic solution at the R+D Lab; Michelle Kaufmann gazes up at a roof study that's now more art than prototype; Eliot Postma of Heatherwick Studio, Google's Michelle Kaufmann, and Leon Rost of BIG enjoying a workshop day.

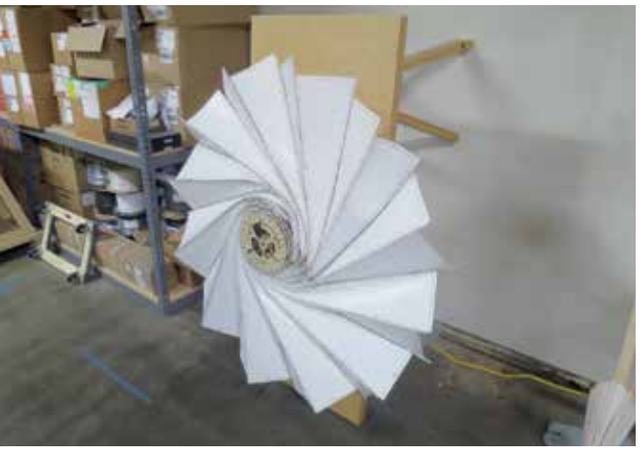
In your own words, can you describe what you do at Google?
I run the R+D team within Google's real estate and workplace services group to help create solutions to Google's highly ambitious goals around the built environment – goals to significantly reduce carbon and create buildings that produce their own energy, filled with creative spaces where Googlers are happy and healthy and can do their best work for decades to come.

How did the Google R+D Lab for the Built Environment get its start?
We started because of Charleston East and Bay View, which was a time when we were figuring out how to do workplace interiors differently. Google set the standard for workplace design back in the day, creating fun and quirky environments that supported Google's business. From day one, Google established a mindset of saying, "If we make spaces that are great for the people working in them, where they're happy and healthy, the business is going to thrive." That was a new concept at the time but continues to be true. Some of the early trends for Google's workplace had to do with audacious ways of thinking about frictionless workplaces, casual collisions, sustainability, and health and happiness of workers.

When we started thinking about ground-up buildings in earnest in 2015, our VP of real estate, David Radcliffe, thought we needed a new type of process to work toward this goal. The typical way of designing buildings just wasn't going to work for Google. We realized we needed to make things in order to talk through our architectural ideas. That's when the R+D Lab for the Built Environment was created.

It sounds like Charleston East and Bay View began from a place of making.
That's right. There's nothing like touching and feeling a physical built thing to help advance understanding, especially among a wide range of brain types on the





This page, clockwise from top left: A pinwheel that informed early canopy thinking; an example of our R+D Lab exploring how to add photovoltaics on facades; VR was leveraged extensively in the preliminary design, earlier than what's becoming an industry standard.

teams, from designers to engineers, builders, carpenters, and managers. It's so different to have a conversation where you're actually touching a thing – modifying it, sitting in it, climbing it – rather than simply looking at a rendering. It's a more powerful way of imagining and creating things together.

During the early concept days, Google's leadership team and the architecture and engineering teams would come over to our makeshift R+D Lab where we would build things as we were talking about them. The leadership vision was really out there in terms of the level of ambition and market availability. So to deliver on the audacious goals and vision of the project, we couldn't just order readily available products and systems in the market. We had to try out new things – in some cases, products not on the market, and new, innovative ways of using existing materials and systems. This requires building prototypes and mock-ups and testing them, failing fast, and then improving quickly based on the learnings. That is our process and our DNA.

The lab is a place where we can study, build, and test, but we can also utilize multiple projects to help expand how much we are able to do. A single project has constraints of budget and schedule that can make it difficult to support the full time and cost that R&D requires. However, if the innovations support multiple projects in our campuses, then we can make meaningful progress.

How would you summarize the overarching project ambitions for Charleston East and Bay View that also informed the creation of the R+D Lab?
We started with three concepts as our anchors: innovation, nature, and community. At the same time, we were driven by the idea of future flexibility. We said, "We

know how we work now, and we know we're going to work differently in five to ten years, but we don't know exactly what that will look like." We asked, "What will our buildings need to be now so they can be vibrant for decades to come?" To do this, we looked to the past and researched buildings that have been highly utilized, with multiple types of programs, for centuries. The common properties of these projects were high ceilings with double-height spaces in areas, longspan structural bays, access to daylight in most spaces, large flexible floorplates, and exposed authentic structures. So those became the key ingredients for these projects.

This page, clockwise from top left: The R+D Lab prototypes different ways to support focus at the desk level; glass-integrated photovoltaic solutions; an inflatable collaboration space prototype that can be mobilized in minutes.

The baseline was always extraordinary user experience. We wanted to make sure that our innovations were being driven by Googlers, so we had a group of 20 Googlers from around the company come to the R+D Lab monthly to try out different things and give feedback. At the same time, the innovations also had to be highly sustainable, healthy, and high-performing. But what was fascinating – and also very challenging – is we had to do all of this in a way that was scalable to the whole industry, meaning the solutions had to be economically replicable beyond this project. That was the hardest part, but also the most rewarding part, because it meant we were using our buildings to be great for Google, and simultaneously a means to unlock advancements that could benefit the entire industry.

How would you compare the Charleston East and Bay View design process to a typical design and construction process?

Many traditional projects don't build mock-ups except for during construction, to create a quality control sample. That late in the project, it is difficult to make changes to improve based on learnings, as it's very expensive and the magnitude of changes is limited. So with the R+D Lab on this project, we created mock-ups at the

Above, clockwise from left: The team studied different lighting strategies of the canopy in the R+D Lab by constructing and testing them for light levels and experience; a solution to leverage cross-laminated timber with concrete was employed in Charleston East for sustainability and aesthetic benefits; various sketches, plans and materials being studied at the R+D Lab.

very beginning, even during early concept design and schematic design phases. Our thought process was: It's OK if the mocked-up ideas fail as long as we push hard on the vector of innovation toward our highest priorities, fail fast, learn fast, and evolve the ideas quickly based on those learnings – so that it doesn't fail when we get down to the end of the process when we're in construction. Some of the key aspects of 10x thinking innovation-wise are about having lots of failure; otherwise, you're not being ambitious enough. But obviously, you can't have a building fail. Which is why innovation and building construction typically do not go hand-in-hand. That's one of the key reasons we established the R+D Lab, so the work can happen *before* the project starts, to help unlock innovation.

What were some of those early mock-ups produced in the R+D Lab?
Often, it was about testing solutions that addressed the project's high ambitions. For example, because we wanted longspan interior spaces with minimal columns so we could keep the interiors highly flexible, at one point we asked, "What if we made the whole building an inflatable structure?" (We studied this approach and built mock-ups, but ended up not proceeding with it.) We also explored ideas around glass canopies, and a type of handkerchief origami with solar panel surface that would open and close depending on where the sun was – to reduce heat gain and glare for the people in the building, as well as producing the building's energy. For most of these innovations, and those we continue exploring today, we research what possible solutions are on the market, near the market, or don't yet exist. If they don't exist, we go back to first principles of physics and

come up with solutions based on what is physically possible. And go from there. The process means we are able to test ideas against factors such as cost, schedule, and performance, but also elements like healthy materials and environmental impact. It's a way of balancing between large-scale ambitions and values on a construction project, and the tangible innovations that help you figure out how to realize those ambitions at scale. All of this informed the overarching mission for our R+D Lab for the Built Environment, which is to create scalable innovations for the future of Google's workplace.

What criteria did you use to decide which ideas made it out of R+D and into the buildings?

We were constantly testing different combinations of ideas on how to solve an issue. We used VR, mock-ups, models at various scales, and user testing to gather feedback and help us choose what worked best from a human experience perspective. Experts on the team were analyzing the actual buildability of these things and how to solve them from a technical perspective. It was about bringing together diverse voices and offering different perspectives on what would meet our goals and objectives. In the end, the best ideas were those we co-created together as a team.

Below, left to right: Google's Michelle Kaufmann finds respite in a suspended chair; Eliot Postma of Heatherwick Studio looks at an inflatable light fixture in the R+D Lab.

Healthy Places and Holistic Sustainability

Mary Davidge
Former Director of Global Design

"The goal was to develop both of the sites in a way that integrated with the landscape and would help restore the land to make it more resilient."

Opposite page, top to bottom: Adaptive reuse of Howard Hughes' Spruce Goose Hangar into a Google office in Playa Vista, California; a view of an atrium in Google's Moffett Place office in Sunnyvale, California; Mary Davidge stands on the roof of Charleston East before solar panel installation.

What was your role on the Bay View and Charleston East projects?
I was the director of design for Google's real estate and workplace services group. I started working with Google in 2004, helping manage the design of the Googleplex, which is when I was introduced to the vision of the founders for the design of their spaces. Prior to that, for 15 years, I was a partner in an architecture firm, and in 2003 I started my own design and sustainability consulting practice.

From 2004 to 2010, I consulted on a number of different projects, including Charleston East and then Bay View. In 2010, I helped to build Google's first real estate sustainability team. Then, in 2014, I became director of global design and my focus was shifted to the development master plans and the design of our first ground-up campuses: Charleston East and Bay View.

What was the nature of that early work, 2004–2010?
We primarily focused on creating design guidance for Google's growing real estate portfolio that incorporated the best research on a "healthy, sustainable work environment" and developing master plans for the future campuses. Much of the early work was getting the right teams in place to bring the concepts to life, and Bay View and Charleston East are an evolution of that work.

How were you defining "healthy, sustainable work environment"?
A "healthy, sustainable work environment" meant that it was healthy for the Googlers as well as the environment. It meant that we were not only eliminating toxins in building materials, but also adding elements that would support more vibrant health. From the very beginning, Google's leadership pushed for science-based design drivers. For example, research indicated that access to nature supported cognitive performance and reduced stress, so we dug into the best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evidence-based science available. It's amazing to me that they were asking for these things all the way back in 2004.

A healthy work environment also meant that the spaces worked for teams and created, as much as possible, a friction-free experience, helping Googlers to do their best work, allowing them to quickly form and co-locate, but also easily access support spaces and amenities. It needed to accommodate not only project collaboration, but also quiet concentration and informal meetings.

How would you compare Google's early research on sustainability and biophilia to industrywide thinking in the early 2000s?
At that time, we were asking questions that were difficult to answer. For example, when we started thinking about healthy materials, it was a struggle to get any kind of transparency around what was in the building materials we were using. In 2004, when we were working on the Googleplex, we had to hire someone simply to do research on the ten materials we were most concerned about, because that information just didn't exist. And I give Google so much credit for asking the hard questions. It really shifted the market.

Over time, systems like Cradle to Cradle and other third-party certifications became more prevalent. Google made a grant to the U.S. Green Building Council in 2012 to delve into healthy materials more deeply, with the idea that we needed a rigorous vetting process for the LEED rating system.

Early research on biophilia was also not very far along as we were developing Bay View and Charleston East. We added biophilia to our Indoor Environmental Quality (IEQ) guidelines and tested the concept on interior projects and masterplans. Google was one of the first to recognize that you had to provide science-based guidance so that design teams would understand the important features and how to apply the research.

When the International Living Future Institute's (ILFI) Living Building Challenge (LBC) certification system was introduced in 2007, that was a game changer for us. It meant that someone else, a third-party organization, was articulating the things that Google thought were important in sustainable, regenerative design.

How were you and Google defining "sustainable" design at that time?
I think the word "sustainability" has been a useful word in the industry. But we knew we needed a more holistic, integrated approach to the health of people and the environment. You have to design one system at a time – such as mechanical systems, indoor air quality, thermal comfort, energy efficiency. But it has to start with the big picture, using systems thinking, looking at the whole, and planning for how these systems will be integrated for the most holistic outcome.

How did research figure into the early work on Bay View and Charleston East?
My team helped collect the most relevant research and identify experts who could be trusted sources to help us to apply the science. Often, we noticed a gap between finding the best science or innovation, and then figuring out how to apply it. This was the intent of developing our own R+D Lab: accelerating the application of research. By the time we started Charleston East and Bay View, which were incredibly aspirational projects, we had assembled a significant body of research on the design features we believed would have the most beneficial impact on the users and the environment. All those years of research made a big difference to Google's ability to deliver these projects.

Can you summarize those early aspirations for Bay View and Charleston East?
Beginning with our early concepts for development in Mountain View, the ideas were driven by the need to create a high-performing environment for Googlers

Opposite page, clockwise from top right: A courtyard at 1212 Bordeaux in Sunnyvale, California shows Google's commitment to connecting employees with nature; the outdoor dining spaces at the Quad campus in Mountain View, California; the interiors at Spruce Goose integrate seamlessly into the adaptive reuse hangar's inspiring heights; the upper floor at 1212 Bordeaux took inspiration from Bay View and Charleston East's design; a view of the native plantings and pathways through the Moffett Place campus in Sunnyvale, California.

while also meeting aspirational environmental goals. It was about optimizing the experience of the user. When we talk about sustainability and other goals on this project, it's important to note that we were always framing it around our larger design principles.

For example, one principle was access to nature. Biophilia was not just a requirement for the building, but there was also a need for Google to create natural area standards. The goal was to develop both of the sites in a way that integrated with the landscape and would help restore the land to make it more resilient. One of the key principles early on was to look at solutions that are multifaceted – solving more than one problem. For example, the water retention ponds at Bay View not only collect water for reuse, but also provide nature restoration, sea level rise protection, and access to the beauty of natural wetlands for both Googlers and the public on the Bay Trail.

Below: Early renderings of Bay View with a focus on habitat restoration and link to Bay Trail providing connection for pedestrians and bikers.

How do you see that multifaceted approach manifesting in Charleston East and Bay View?
At Charleston East, the healthy materials story is a game changer. We are targeting the ILFI's Living Building Challenge Materials Petal, and if you can achieve that on

Above: A rendering of the Eco Gem, which is part of Google's proposed master plan for North Bayshore in Mountain View.

a project of that scale, who has an excuse not to do it on other projects? The same thing is true for habitat and water at Bay View, which is targeting the LBC Water Petal. I remember walking the Bay View site years ago, at the start of these projects, and realizing that most development in the area had turned its back on the Bay and that we had an opportunity here to restore that connection. We could see the potential. Restoring the wetlands, developing the whole water system for the campus, integrating the interior, architecture, and landscape – all of that helped inform the Bay View design in a beautifully holistic way.

A takeaway for us was that sometimes you might think certain things are impossible, but the right technology can come along later to give it a powerful outcome. Never throw those early ideas away – they might be helpful down the road.

How were you approaching the notion that technology and ideation might not always be on the same plane?
For us, it was about creating opportunities to brainstorm and get diverse perspectives. We wanted to gather the smartest people we knew in these various sectors and put them in a room together to talk about how to solve a particular problem. And then, out of that messiness, a few ideas would rise to the top. As I look back at my 40-year-plus career, I can't tell you how often the answer has come when you get people together that don't normally work together. You have to make space to explore the edge cases.

It was also important to bring together the ideas people and the practical team members who deliver the projects. Sometimes, the best solutions also arise from getting competitors together. For example, putting BIG and Heatherwick together on these projects. That wasn't the first time Google did something like that.

Why was collaboration so important to tackle the issues Google was trying to address with these buildings?
I don't know that you could get to the level of technical aspiration we sought without having teams that brought together innovative thinking, technical expertise, and strong delivery skills. It required a combination of qualitative and quantitative thinking. The artist and the engineer. Today's building problems require diverse perspectives and experience.

There are plenty of examples of projects that perform well in sustainability, but are not places people want to be. We wanted to create buildings that would withstand the test of time, and would help Googlers do their best work. Thus, the creative, humanistic side was very important.

What do you hope people will take away from these buildings?
I believe these buildings will be a bridge between Google's past and future. Hopefully they will express Google's unique culture but will be adaptable enough to allow for what is needed in the decades to come, a world we can't yet imagine. We know the workplace will be very different, and my hope is that the foundational principles that drove the design will hold up: science-based design solutions that embrace the beauty, magic, and art of great design. Places that serve the occupants, making their lives healthier, while also helping to restore and respect the natural world around us.

Above, top to bottom:
Construction workers problem solving on-site; Michelle Kaufmann, Mary Davidge, and Drew Wenzel of Google enjoy a workshop day at the Google R+D Lab for the Built Environment.

Opposite page, top to bottom:
Ecological restoration has been an important part of Google's development work in Silicon Valley; this red-tailed hawk is a "frequent flyer" and observer of Bay View's construction.

A Conversation on Design Performance

Kate Turpin
Director of Design Performance

"One piece is simply how *much* innovation happened on the project. It's not as if there was just one moment of innovation. The way they all came together is some of the project's magic."

Opposite page, clockwise from top: Green wall installations at a Google office; an early visualization of a desk space at Bay View with a focus on views; Google's Michelle Kaufmann (left), Drew Wenzel, Kate Turpin, Chris Alwan, Parham Khoshkbari, and Asim Tahir at the Charleston East groundbreaking; focus areas with great views at a Google office.

When did you join the project, and what is your role on the team?
I joined Google when Bay View and Charleston East were in early design phases in 2015. My team helped set the big, high-level goals in those early design phases of the project, and then made sure we had great consultant team members to achieve those goals, particularly in technical or engineering specialties. Essentially, we help set Google's technical design criteria and goals, and then help to assess how architectural and engineering design concepts achieve them.

What is the focus of "design performance" for Google?
We focus on areas where Google's values push us to achieve outcomes well beyond standard industry practice, in particular on aspects of the built environment that contribute to experience, health, and sustainability. For Bay View and Charleston East, my team worked heavily on the sustainability aspect, particularly as it related to energy and water use as well as many of the experiential elements of the buildings with a technical aspect, such as daylight, lighting, views, acoustics, and biophilic design.

What were the key values and goals your team helped define for Bay View and Charleston East?
First off, we wanted to create incredible team workspaces where people could focus and also collaborate with their teammates. That informed the architectural approach and much of what the second level in each space turned out to be. Google had spent quite a bit of time before these projects trying to understand what "an exceptional indoor environment" meant. They were looking at it not just from an aesthetic point of view, but from an environmental quality lens (things like light, glare, acoustics, thermal comfort, indoor air quality, etc.). The other big piece for us on Bay View and Charleston East was biophilic design.

How did you understand "biophilic design" for these projects?
For us, this was about leveraging available research on how regular access to nature improves human health, happiness, and performance, and applying that to the design of the building. It's about integrating nature with design to create habitats where people thrive. That manifested for us in a couple of ways. First, there is a variety of space types and courtyard designs that provide different kinds of experiences. We were trying to evoke some of the physiological, psychological, and emotional responses that people have in an outdoor environment and bring that indoors. In nature, some of those experiences are stimulating, and some are calming. We wanted that variety. We wanted the buildings to provide a rich, variable, multisensory environment.

We thought a lot about people's many different pathways through the building, and how they might use different amenities and space types throughout the day. Good designers always think about these things, but we were considering how it was meeting a variety of different physiological and psychological needs. For example, we thought a lot about the concepts of "prospect" and "refuge." Prospect being the moments where you get long, distant views, and balancing that with moments of refuge where you don't feel completely exposed. In that sense, it was important to provide places of retreat and refuge to counter the experience of prospect that you feel very strongly on level two.

Another way we approached biophilia was through the handling of daylight. Rather than having a monotone quality of light, we wanted to have dappled light, much like you get in a forest when you're hiking on a sunny day. However, we couldn't have that dappled light go onto desks, because of thermal comfort and glare. To address this, there was a great deal of technical rigor applied to figure out when the clerestory window shades should be opened or closed to allow direct beams of sunlight into the courtyard spaces for that dappled light effect, while also keeping the desks in that area free of glare and direct sun.

We also did a lot of work on the electric lighting integration to make sure it tracked to the way your eye responds to the different weather conditions outside (i.e., a bright, sunny sky versus an overcast or night sky). It was tricky because the canopies are so expansive in the big, large-volume space on level two of the buildings – and it was important to keep the fixtures in places where they could be accessed

Below: For architectural emphasis, a photo of Bay View shows light coming through the clerestory windows. Typically, building interior lights are programmed to cycle off and the shades are deployed at night to minimize light pollution.

Above: An early visualization of Bay View's ecological aspects that considers tidal marsh and wetland elements.

and maintained over time. But it was also important to make sure we were creating an indoor environment that was responsive to different levels of outdoor light and really felt good to people inside.

What are some other innovations from this project that stand out to you?
There are so many, and one piece is simply how *much* innovation happened on the project. It's not as if there was just one moment of innovation. The way they all came together is some of the project's magic.

The dragonscale solar roof was a big one. Just thinking about the shape of the canopy and covering that in photovoltaic panels is amazing. Looking back, there was an interesting tension between design and performance, and getting the technical aspects and the aesthetics to work together. For example, the color of the panels was a point of debate, because black was going to be much more productive for solar than white, which was the original design preference, and we ended up somewhere in the middle colorwise. There was a great deal of complexity in trying to get that scale of solar right in that particular application, and also make it beautiful.

The water system on Bay View also stands out as an important innovation, and an incredible story. Particularly the fact that it's tuned to its environment being right on the edge of the Bay, and not only treating all of the wastewater to near-potable use, but enabling us to not have to use regional potable water sources for non-potable uses. What's more, the system creates natural area and an incredible landscape feature for the site, so people can see and interact with that system. Systems like this exist elsewhere, but the more of them the better, because it changes people's perceptions of what wastewater treatment can be. It shows that these systems can be an incredible experiential element of a site when it's done thoughtfully, and can add biological richness and diversity, bringing in birds, pollinators, wildlife. Charleston East is also doing rainwater capture and reuse.

We also had to think about the canopy and get the sound absorption right there, because otherwise it could sound tinny and reverberate, and could get too loud. There were moments when we were seriously considering cutting some of the sound absorption out of the canopy. When we looked at the numbers and the graphs, everyone thought it would be fine to cut it. But we felt it was important

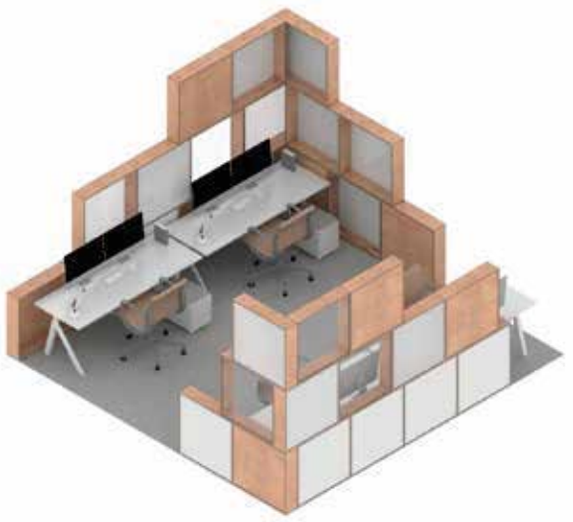
for people to make the decision from an experience-based perspective, so we actually built an acoustic sound model and did a simulation of the sound with the different options so people could understand how it would feel in the space. We wanted an integrative process where people would come to decisions together. In the end, after experiencing and listening to the simulation, everybody – contractors, designers, everyone who went in thinking we should cut the sound absorption – decided it was worth keeping.

It seems unique to have such an emphasis on human experience, all the way through the design process. Was that a factor that helped you achieve the level of innovation on this project?
Absolutely. And that's just one example. I've never seen that level of acoustic analysis done on an office project, but it was warranted because we were doing something so unusual with the structure and the architecture that it would not have been responsible to answer that question without it. It wasn't enough just to run the analysis. People had to get the sense of it experientially.

Not everyone has the resources to achieve this scale of analysis on projects, so what aspects of your process are transferrable to the wider industry?
No matter what internal resources or staffing you have, focusing on integrative design is possible. It's about prioritizing it and knowing you need to spend time upfront to build the team, get alignment, get all of the goals sorted out, and then ask the right questions and understand the trade-offs early on. If you don't do that, you run the risk of unwinding as you find mistakes later, and it can lead to huge misses. I don't think it takes Google's resources to adopt that mindset. I've worked on federal government projects, university projects, market rate projects, and it's possible everywhere. If the owner asks for an integrative design process, then spends time on the front end to clarify goals and vision, and puts the right metrics in place, that's the most important thing to set a team up for success.

But a caveat is to remember that every project can't be everything. That was a hard lesson to learn on Charleston East and Bay View because Google did start out with

Below: A sequence looks at potential configurations for smaller team pods of up to four desks.



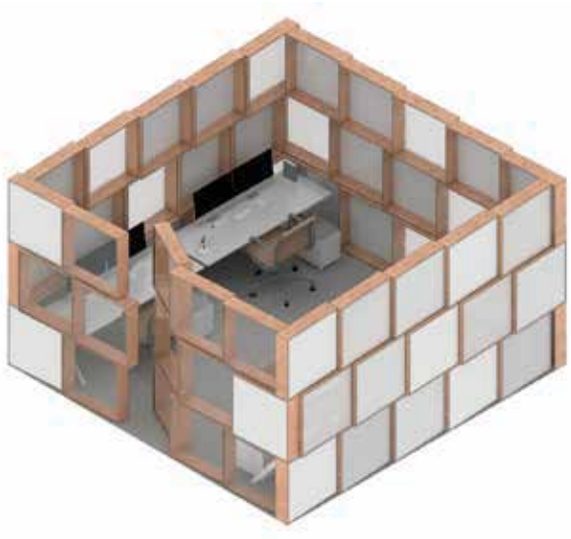
wanting it to be everything – every aspect of the projects was aspirational at the start. We had a lot of hard conversations to figure out what was most important. That is one of the biggest takeaways for us, which we're applying to future projects: clarifying our own values as well as priorities. That clarity has allowed other projects to be more streamlined in their drive toward innovative solutions.

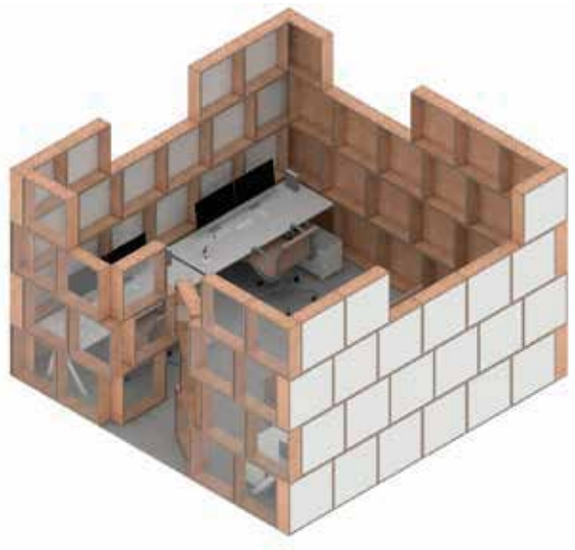
What do you hope the impact of this project will be on the wider industry?
A lot of the sustainability accomplishments we achieved on this project are incredible, particularly because of the scale at which we were working. Things like healthy materials and waste management. I hope that this project takes away some of the general reaction to these things as, "No, they're too hard," or, "We can't achieve those things at scale." It is achievable, and doesn't always have a huge impact on cost. It takes effort and attention, but it's achievable.

This project speaks to the importance of vision and the importance of establishing audacious goals upfront and uniting a team around them. But remember, not every project has to be all things. Many of our projects have taken big leaps forward on sustainable design or healthy workplaces, but not every aspect of those goals is pushed to the limit on every project.

How is this project advancing definitions of "sustainable design"?
In the industry at large, "sustainable design" can be applied in a way that's not very human-centric. I'm coming from a place of starting my career totally focused on energy efficiency, and I truly still believe that's important. But if you don't take a holistic view, you can actually maximize or optimize for one thing and end up making some trade-offs in the end that are not desirable and don't result in a building that stands the test of time. I think that's happened a lot in our industry over the years.

What's fantastic about these projects is that they are ambitious and achieved great outcomes in environmental sustainability, but they did it in a way that didn't compromise in any way the human experience. Instead, they enhanced it.





Healthy Materials and Regenerative Design

Lauren Sparandara
REWS Sustainability Partner

"Healthy materials not only create healthy workspaces, but also create healthier and more sustainable supply chains."

Opposite page, top to bottom: The 1842 Shoreline building emphasizes Google's healthy materials efforts for interiors; the sustainability team including Kelly Stone and Ali Flynn, on a site walk to spot-check that all materials delivered to the construction site had been reviewed and approved for healthy materials requirements; dumpsters at the Charleston East construction site were dedicated to individual materials to maximize recycling rates; Google's Lauren Sparandara stands in front of a local Material Recovery Facility (MRF).

What is your role at Google generally, and specifically on the Bay View and Charleston East projects?
I am Google's Bay Area real estate and workplace services sustainability partner. I help develop the sustainability goals for our Bay Area real estate projects, and I convene our internal stakeholders across facilities, construction, design, and development teams to help meet Google's corporate commitments around sustainability for carbon, water, waste, and ecology. For the last few years, I have also been leading efforts around circularity in the built environment.

My team and I worked on driving Charleston East toward achieving the International Living Future Institute (ILFI)'s Living Building Challenge (LBC) Materials Petal, and LEED Platinum for both Charleston East and Bay View. We also made sure that the projects aligned with and tracked toward Google's corporate sustainability commitments. We had worked on healthy materials as a team for many years, but Charleston East was the first time we tackled it at this scale. For that reason, my team took a much bigger, more hands-on role specific to healthy materials on these projects.

Can you give some background on Google's interest in healthy materials?
In the early days of Google's founding, Google's co-founder Larry Page walked through our offices with a hand-held particle counter to measure our indoor air quality. There was a great deal of initial curiosity built into Google's culture around understanding our indoor environments and making sure they were as healthy as possible. That initial prioritization of the indoor experience very much informed our work here. Mary Davidge, Google's former director of global design, and her team also played an essential leadership role in working with project teams to review their interior materials to optimize for the health of the indoor environment.


GREEN WASTE
RECYCLABLE PLASTIC
WOOD

In the past, Google was building interior fit-outs of existing buildings, rather than ground-up construction. That meant we were often reviewing materials like carpet tiles, paints, coatings – materials you'd have in typical tenant interior (TI) refreshes. Mary and her team started reviewing and making phone calls to manufacturers about those products, using the LBC Red List as a framework, and asking about the composition of these materials. Over time, Google helped transform the fundamental questions being asked of the building industry simply by repeatedly saying, "We care about this, and we want to know more about what is in your products."

Pursuing certifications like LEED Platinum and the LBC Petals are ambitious goals. How did Google approach this process?
Going into these projects, Google had just completed an LBC Materials Petal and LEED Platinum certification at Google's Chicago Renovation. It was a big deal for us, and for the building industry at large, because of the scale of that project, which is close to 250,000 square feet.

It was a whole new frontier to tackle the healthy materials effort at Charleston East because we were encountering completely new manufacturers and building materials, especially for materials people don't often talk about, such as underground piping, roof insulation, or the fireproofing coating on structural steel. There was a steep learning curve for everyone on the project. On a project like this, there are a whole host of design, code, and general performance expectations of materials. Requiring healthy materials was just one of many requirements that the design team had to address. Therefore, much of our healthy materials effort was about helping everybody – from designers to engineers to contractors – understand why this was important and how to align on a shared vision.

We then spent a lot of time upfront trying to understand costs and trade-offs for pursuing these ambitious sustainability certifications. We sometimes didn't yet know what we didn't know, because there weren't many precedent projects we could look to to understand how to achieve this at the scale of Bay View and Charleston East.

Knowing that it was a big risk at the time to pursue these certifications, why take it on?
It's very Googley to take on things that can seem impossible to achieve. That's the beautiful thing about a challenge: It inspires you. The challenge pushes you, and it

Below, left to right: Non-toxic finishes were used on all woodwork; Lauren Sparandara examines the contents of a dumpster during a waste-focused construction site walk with the City of Mountain View Sustainability Team.

gets you and the building product industry to rethink some of its assumptions. For us, that certainly happened with materials, and with waste management.

We pursued LBC because it is a holistic rating system, and one that is radically ambitious and transformational. At Charleston East we reviewed thousands of materials against the LBC Red List with the goal of minimizing or eliminating toxic substances in the project. For example, we aimed to eliminate polyvinyl chloride (PVC or vinyl) throughout the building. Vinyl has come under increasing scrutiny over the last two decades because toxic substances are released during its production, use, and end of life. Vinyl is also a carrier of hazardous chemical additives such as brominated flame retardants and phthalate plasticizers (see Bill Walsh's October 2021 article on the Healthy Building Network, "Addressing the Plastics Crisis: Why Vinyl Has to Go"). This kind of effort for an entire building is exceptionally challenging and LBC requires that the project find ways to advance towards more sustainable material selection and construction.

Another aspect that resonates within Google is that LBC encompasses a wide range of sustainability dimensions, which forces you to think holistically in design, construction, and operations. For example, in addition to health, we also factored in other material variables like sourcing lumber from responsibly managed forests, supporting local tradespeople, calculating our embodied carbon footprint, and diverting over 90% of our construction waste from landfill. The waste goal in particular required us to think creatively about persistent issues in recycling, like what to do with plastic film waste. We ended up partnering with a local startup to pilot their chemical recycling infrastructure for plastic film using scrap from the Charleston East job site. These sorts of unforseen partnerships and explorations are part of what makes LBC such an exciting and challenging framework.

Furthermore, LBC gave us a platform to tell the story of the work we've done to advance sustainability in our workplaces historically, and what we're doing today. Ultimately, I think it's good for the industry to bring these stories forward through programs like LBC, because it shows the world what a better, more sustainable future looks like.

Why did you pursue different LBC Petals on Bay View and Charleston East?
From the beginning, we took inspiration from Google's internal philosophy, "Ten things we know to be true," and the second "thing" in particular which states,

Above, left to right: The curtain-wall coating facility installed new hexavalent-chromium-free infrastructure because of Charleston East; all construction team members participated in zero-waste training and received reusable mugs and water bottles to minimize waste generated at the construction offices.

"It's best to do one thing really, really well." We knew that we couldn't solve every sustainability problem on every project, and that there was value in focusing our efforts to test out specific innovations on specific projects, with the goal to leverage what we learned on future projects. It made sense to focus on the Water Petal at Bay View because of its proximity to the Bay and its natural ecological resources. Charleston East was a logical choice for pursuing the Living Building Challenge Materials Petal. Both projects worked closely together, and were constantly learning from one another. For example, even though the Bay View project did not pursue the LBC Materials Petal Certification, it still reviewed thousands of materials against the LBC Red List simply to be a healthier building and as a partnership with the Charleston East project.

We know why Google wanted to pursue these certifications, but how did you get partners on board? What made the rest of the team willing to sign up for these highly ambitious goals?
Our entire sustainability team has learned over time how to meet people where they are, and present the content in a way that brings everyone along. I credit my colleague Kelly Stone greatly for this. It was about clearly presenting the ambition and the vision, and then starting the conversation on familiar territory. For example, asking a manufacturer to send us their materials list, rather than saying every material in the product has to be Red List-free by tomorrow. It's about inviting people to be part of something great and setting out a practical path for how to get the ball rolling.

How are you leveraging the lessons learned on Bay View and Charleston East on current projects?
We now have a materials standard for all of our TI projects, which continues to learn from our experience at Bay View and Charleston East. All of our global tenant interior projects have a requirement to procure and install products that limit VOC emissions and provide product ingredient transparency through Google-approved third-party industry standards for all carpet, resilient flooring, hard surface flooring, paints, and coatings. Our new development projects have a similar requirement in place that also includes additional core and shell materials.

The sustainability innovations at Charleston East and Bay View have taught us about systems and strategies that will help our global real estate portfolio achieve Google's ambitious corporate sustainability commitments. For example, Google is committed to replenishing more water than we consume by 2030. The lessons we've learned at Bay View around efficiency, nature-based systems, and water infrastructure are shaping our approach to water stewardship across the globe.

What aspects of this project can people apply to their own work?
Ask questions of your project team and the greater building industry. Have curiosity to better understand how all of the existing systems work together. Asking manufacturers what's in their materials is something anyone can do, and it helps manufacturers make the case for investing in healthier ingredients because they know their clients care. That also applies to ideas around waste – simply asking, "Where does this go when it leaves the job site? Does it actually get recycled?" Asking those deeper questions can lead to greater diversion rate percentages.

There is power in setting an ambitious project target and focusing on one major ambitious goal or one big innovation for each project. Anyone can do that – no matter the budget or schedule. It's about leaning into one particular arena of sustainable design and taking it as far as you can.

Finally, I think this project demonstrates the power of having a supportive team with whom you can collaborate over time. It's important to foster that in the

beginning, and cultivate a team environment where people can make mistakes, and then come forward and get counsel and support from one another.

There are so many definitions of "sustainable design." How would you define "sustainable design" as it relates to these projects?
I would define sustainable design on these projects as transformative, comprehensive, and regenerative. "Transformative" in terms of how we were trying to take these projects to the next level, and do things that we hadn't done before, and that the market hadn't really done before. "Comprehensive" because no matter what the topic for sustainability on this project, we dug in deep, several layers past what one might traditionally do. "Regenerative" in terms of how the project team designed interconnected systems with a whole systems approach. For example, the roof not only elegantly captures solar energy for electricity, but also collects rainwater for irrigation and toilet flushing. Healthy materials not only create healthy workspaces, but also create healthier and more sustainable supply chains. I think of Bay View's water systems as having a particularly regenerative mindset by integrating with and enhancing the larger ecology of the region, while also helping people connect to nature and learn about their environment.

Below, top to bottom: Wet meadows and willow thicket habitat support a wide variety of birds at Bay View including the San Francisco common yellowthroat, a species of special concern in California; an early mock-up of team space at Leghorn in Mountain View showing how we're using lightweight materials to create intimate spaces within larger areas.

A Conversation on Energy Systems

Asim Tahir
Director – Energy & Carbon

"We tried to look at everything on this project holistically. There was a continuity from the desk, at the scale of the user experience, all the way to the local ecology and ideas around community resources."

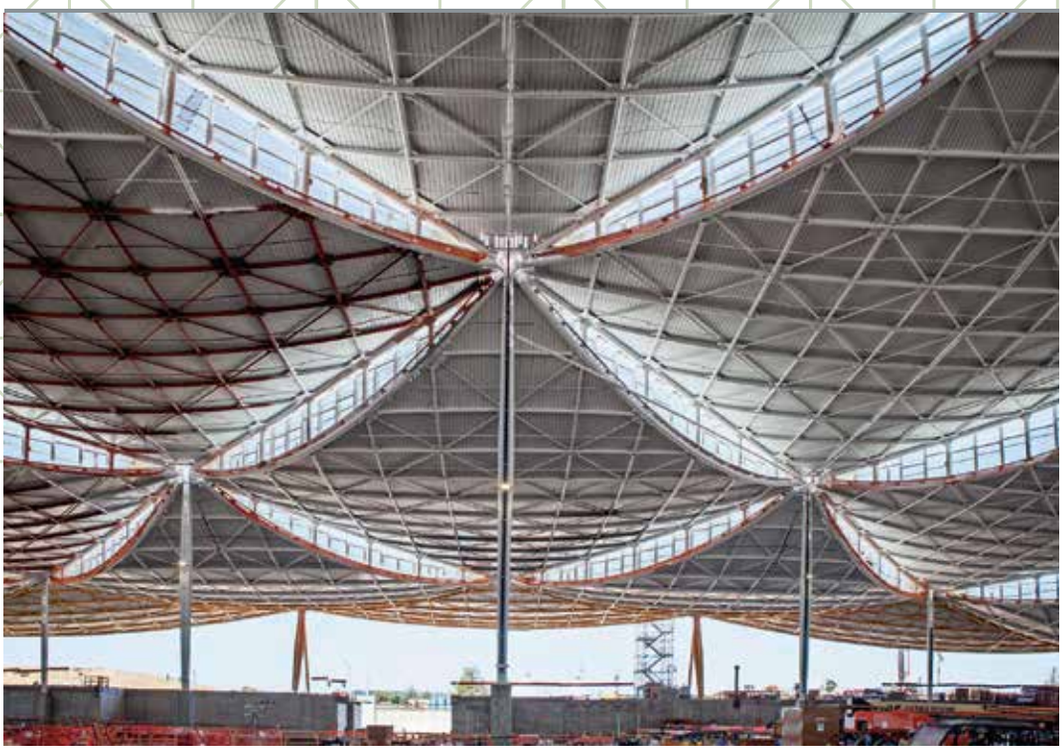
Opposite page, top to bottom: The final installation of dragonscale building-integrated photovoltaics; Asim Tahir and David Radcliffe adjust photovoltaic panels as the team workshops solutions for maximizing solar potential; an interior view showcases the awe-inspiring scale of the canopy roof at Bay View.

What is your role at Google, and specifically on this project?
I was hired in 2010 primarily to drive building performance for our ground-up projects from an operational sustainability perspective. In other words, Google wanted to have somebody on the inside who could drive the design decisions through the filter of Google's values, and translate for the consultants.

Often in high-performance buildings, once the show is over and the keys are handed over, the buildings don't always work as the engineers or the builders envisioned. At that point, nobody's around to help fix it, so the occupants can't live up to the claims made around the building's performance, and the blame often lands on the operations team. Before I worked at Google, I was what you might call "a building doctor." I would go fix buildings that were not performing well, so I had a good understanding of this issue.

My role on Bay View and Charleston East was essentially to make sure that the buildings work, in all senses of the word: as assets for the business, and as environments for the user. My goal was to ensure that we were making complex, integrated decisions for building performance, but in a way that the operational paradigm was straightforward and simple.

What are you most excited about on this project?
It's difficult for me to pick just one thing, and that's because we tried to look at everything on this project holistically. There was a continuity from the desk, at the scale of the user experience, all the way to the local ecology and ideas around community resources. We always find it challenging to define this project under more conventional ways of talking about design or sustainability, because we did not section it off in that way. Everything overlaps, everything is integrated, nothing here has a single job. Every element in the building is doing more than one thing.



Can you give some examples of that?
Let's take the roof canopy. That is our environmental control – we are able to maintain the environment inside, but the canopy is also collecting sun and water. It's also allowing in daylight, but in strategic ways to maintain sightlines and connection to the outdoors for the user.

It's similar when we talk about the geothermal system. We have these large columns that are holding up the canopy, and we needed additional structural supports to hold up the human-scaled elements of the building. We needed approximately 4,000 structural piles for that second layer of structural support, each of which would go roughly 80 feet into the ground. Now, we're running a closed-loop pipe through those piles and using that as a way to activate the thermal mass below the building. In summer, when we're cooling, we take the heat exhausted from the building and store it in the ground, whereas typically you would evaporate water for cooling. So by using a geothermal system, we're also saving water. In the winter, we just extract the heat from the ground and use it, meaning we don't need to burn gas or use expensive-to-run electric boilers. We're simply storing the heat seasonally and reusing it, which makes for a really efficient system.

We can talk about indoor air quality in the same way. With a typical heating and cooling system, you need to recirculate air, particularly when it's too hot or too cold. That means the amount of fresh air coming in the building is reduced to a minimum. Here, our system is so efficient that we don't need to recirculate air to save energy. From a health perspective, obviously, this is more ideal. We were thinking about this much earlier than the COVID-19 pandemic, as we know for communicable diseases like the flu, it's better not to recirculate air.

Below: A close-up of Bay View's dragonscale solar, blending seamlessly with the architectural design to capture solar at different angles throughout the day.

Above: Twenty miles of pipe snaked horizontally around the site to connect all geothermal piles at Bay View to the thermal plant.

The way we do this at Bay View is by using displacement ventilation. Heat rises naturally, so in traditional buildings you have a lot of ducts running overhead that blast air at a high velocity. With displacement ventilation, we're bringing in air at a gentle velocity, and at about 63 degrees. The air then spreads around, and as soon as it finds a heat source, like a human or a computer, that heat rises and it pulls in the air from the surrounding area. As that heated air goes up, it takes any floating particulate matter with it, and we exhaust it from the top of the canopy roof. In the winter, we won't exhaust as much, and in the summer we will be diligent about exhausting and keeping the whole environment more comfortable. The sequence of how everything works together is what allows these buildings to be so efficient.

How do you define that way of thinking?
Some call it integrated design, some call it systems thinking. There are a lot of different terms for it. Initially when we were talking about integrated design on this project, many people struggled. There are all of these complex definitions of "integrated design" that are hard to understand. Instead, we came at it from a place of understanding that if every element does more than one job, that will bring integration. It was about looking at it from the outcome we wanted, which was to minimize waste in all forms.

If there are redundant systems that are doing almost similar jobs, why not combine them? Then, if you're talking about sustainability holistically, anything that you can design *out* of the building, you're saving material. Obviously, aspects like selecting healthy materials are important, but if you can simply remove things from the design, you solve health issues, you solve supply issues, you solve labor issues, and you solve waste issues. You can also think about it from a circular economy standpoint. In nature, nothing gets wasted and everything has a place. It was about finding the common thread in these various frameworks of thinking, which ultimately was about doing more with less.

This page, clockwise from left: Heat recovery chillers at the Bay View thermal plant (blue pipes show the cooling side and red pipes show the heating side); green pipes connect the plant to the geothermal loops in the ground; Asim Tahir looking at the red and yellow pipes that serve the building's heating needs.

How does that mindset connect to Google's aspirations for relating to the local community?

Typically, buildings are designed with a lot of waste. These waste streams then become a burden on the community, because community infrastructure around things like wastewater treatment, garbage collection, etc., need to accommodate that. Our approach of trying to shrink our footprint across all axes – whether it's energy, water, or waste – is not only beneficial to the environment because we're consuming less, but because we were adopting a regenerative approach, it actually becomes a value-added commodity, rather than a burden on the community. It's about consuming less as a means of freeing up more resources for the community.

How does this approach map to current sustainability ratings systems like LEED and the Living Building Challenge?

Those ratings systems are great frameworks to help change the paradigm. But most of them are put together for an industry that is somewhat tied to a conventional way of thinking. We were ahead of that – we weren't in a place where we needed to convince anyone on the team to aim toward those sustainability goals.

Often, we were doing things on this project in such a different fashion that they simply couldn't fit into the calculation methodologies of these ratings systems. We're doing things here they don't have certificates for. The certification entities

are going to continue to evolve, as are the ways we implement these things in our buildings at Google. To me, that's how change occurs: You show how to do it through a test case.

Was it always a goal on this project to advance larger industrywide thinking about sustainable, human-centric design?
Yes. For our leadership, it was most important that the buildings be healthy and productive for the folks who work here. It was about designing the buildings from the inside out, to focus on the user. We were constantly asking ourselves, "Are we solving the right problem at the right scale?"

Process-wise, the idea was to unlock the potential of the team we built, and then allow them to dream. We wanted to know: What is the best we can do? It wasn't about designing to whatever sustainability metric was popular in that particular moment. Our goal was to create buildings that would show how to solve architecture and construction problems in a different way.

How much of this project was working within conventional wisdom, and how much of it was original innovation?
Not all conventional wisdom is bad. You can see this in the way the canopy design – which is common between Bay View and Charleston East – evolved between the

This page, clockwise from left: Google's district systems water lead Drew Wenzel enjoying a moment on a balcony at Bay View with the stormwater retention ponds in the background; Google's Bay View development executive Kavinder Singh installs the last panel of dragonscale PV; the Bay View project team enjoying a selfie including Google's Kevin Antonelli (left), Sares Regis' John deRuiter, Google's Jeff Holzman, Google's Jeffrey Curry, and Whiting-Turner's Eric Thatcher.

“Our hope was that, with the thousands of people working on this project, taking all of their combined experience into account, there were novel solutions if you just provided a little bit of space to come up with creative solutions. It’s a mindset anyone can adopt. And hopefully this project is just the beginning, and those ideas will continue percolating.”

Opposite page: A rare photo, for architectural emphasis, shows Bay View lit up in the evening.

two buildings. Each project had its own structural engineer, and each one came up with different ideas about how to achieve the structure based on the particularities of each building and site. The engineers had their own ways of doing things and their own perspectives, but we challenged them and often tried to find ways to align. Out of that, we learned that you *could* follow the same system on both buildings, but then you are creating a cascading set of issues that you can avoid by simply letting them be separate. On the whole, we listened to our partners who had a lot of construction experience. We were looking to mine their knowledge and their experience, and get their help on implementing something completely different that was guided by our vision. We really sought to build a collaborative, integrated team.

There are many prevalent industrywide myths, such as: “If you want a healthy building with a lot of fresh air, it won’t be energy-efficient, because all that fresh air will need to be cooled, and you’re going to have an energy penalty.” You can’t think about these questions on a single axis – you often have to go off-axis to find a solution. One of the earliest principles of Google is “a healthy disregard for the impossible.” Our hope was that, with the thousands of people working on this project, taking all of their combined experience into account, there were novel solutions if you just provided a little bit of space to come up with creative solutions. It’s a mindset anyone can adopt. And hopefully this project is just the beginning, and those ideas will continue percolating.

What do you hope this project will mean to the wider industry?
I hope it shows people that there is more than one way to solve a problem, and that it demonstrates how to keep options open. There are plenty of reasons that all of the innovative aspects on this project could have been excluded. The project executives would have been perfectly within their rights to say, “We don’t have a pathway to execute this or that particular concept.” But this project shows the benefit of leaving things open until the last possible moment, and during that time, trying to actually figure out the issues that were giving us pause. I hope this project can shift some of the linear ways of thinking within the industry, and show that another mindset is not only possible, but can yield higher value in the end.

A Conversation on Workplace Interiors

Josh Bridie
Director - Global Interior Design

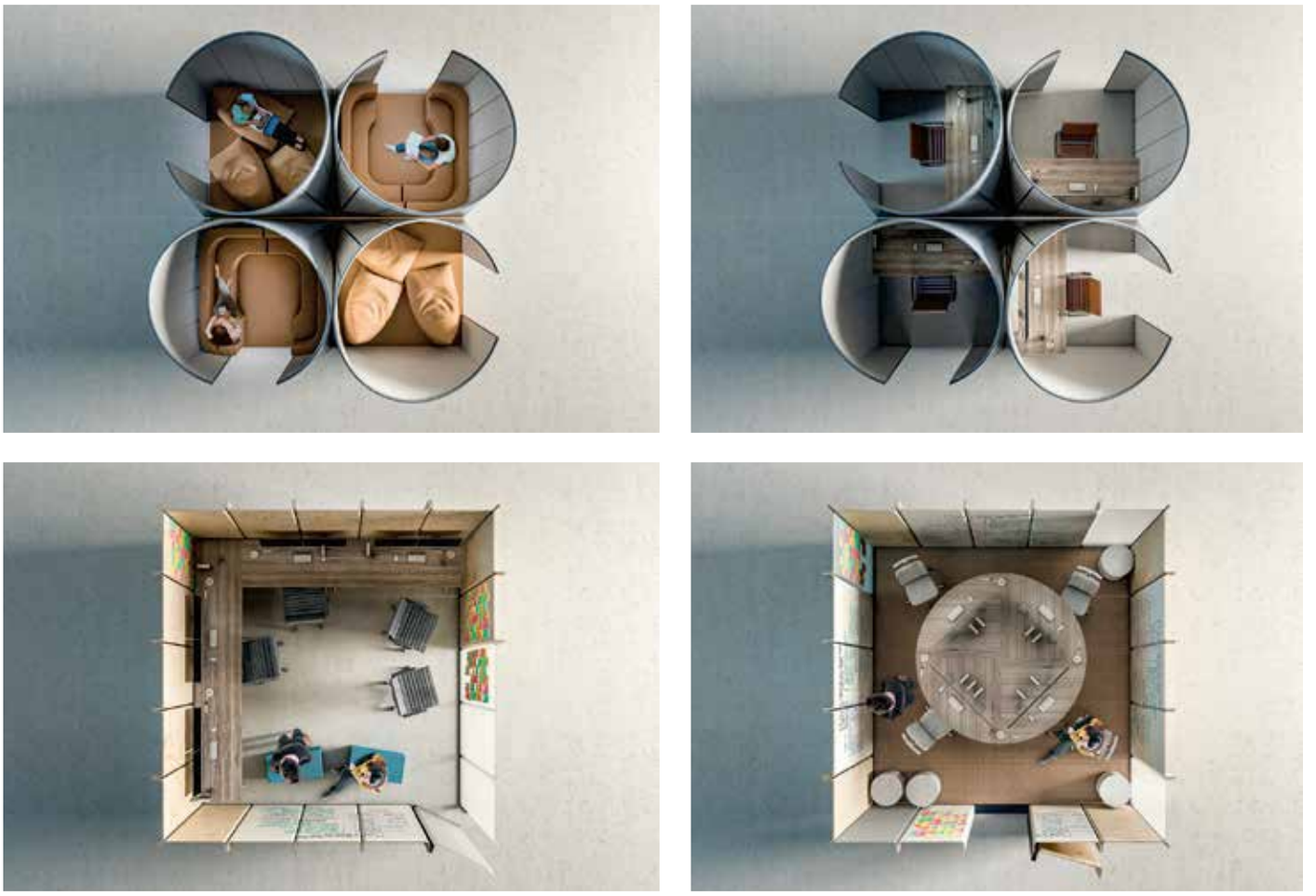
"The desire for flexibility and designing for an unknown future is what drove the interiors of Charleston East and Bay View."

Opposite page, top to bottom: Google's Jeffrey Curry and Josh Bridie take a break from a workshop; a rendering explores a courtyard feature stair for Bay View; a view shows a pathway of conference rooms of various scales.

When did you join the project, and what is your role on the team?
I am the director of global interior design within Google's real estate and workplace services group. I joined the team in 2016, specifically to lead the interior design efforts for Charleston East and Bay View. At the time, the approach to building a team was akin to a three-legged stool: We had a subject matter expert in architecture, one in urban planning and landscaping, and one in interior design. My role was essentially to work closely with the design teams to develop the human-scale aspects of the projects.

How did you conceive of those human-scale aspects of Bay View and Charleston East?
We focused on two major workstreams to break down that experience: one functional and one aesthetic. The functional approach was ensuring that these buildings would not only be amazing pieces of architecture from the outside, but that they were designed to support the individual inside. And, even more specifically, to support the individual within their team. The aesthetic approach was part of developing a larger, global point of view on what is Googley in our spaces.

How did the functional approach manifest in the building's interiors?
We parceled out the floorplates in such a way that each team would have a designated area – their home base – but that the building's infrastructure would support ultimate flexibility within that parcel. For example, there are wall systems which can contain different types of furniture, all of which can be converted easily over time. We thought about the ease of conversion in three different time scales: two minutes, two hours, and two days. How quickly can individuals convert their own desk in two minutes? How can teams convert their parcels within two hours to suit a new task? And if there needs to be a broader, facilities-based change, how could we achieve that within two days?



Above: An exploration of different partitions that can be deployed readily and easily for a small space showcases the focus on flexibility to meet team needs over time.

We're dealing head-on with the realities of a truly hybrid work environment where we need to have spaces that can adapt easily to meet the moment. However, that desire for flexibility and designing for an unknown future is truly what drove the interiors of Charleston East and Bay View.

How would you contextualize that design agenda within the larger sphere of workplace design at the time?

The way we have been thinking about flexibility, and the scale at which we're implementing it here, is radical for the industry. We're not the first, and we certainly won't be the last, to think about why people are coming to the office, and designing to ensure the spaces meet those needs. However, the focus often gets put on amenity spaces, which then become the glamour shots for workplaces in design magazines. I've really challenged the team to lead with the desk space, and strive for that to be the glamour shot. Of course, amenity spaces will always be important for encouraging serendipitous encounters and respite from focused work, but we also want to make sure the experience that Googlers have at the desk for eight hours a day is just as intentional and thought-through.

How did you understand the relationship between focused space and collaboration space in these buildings?

We have years of data collected through site observation, surveys, and one-on-one interviews with Googlers to understand what's working and what's not working in our interiors. From our research, we know that a large amount of the daily collaboration between teams actually happens at the desk. But the way desks have traditionally been laid out in a workplace doesn't lend itself to successful collaboration without distracting others in surrounding areas.

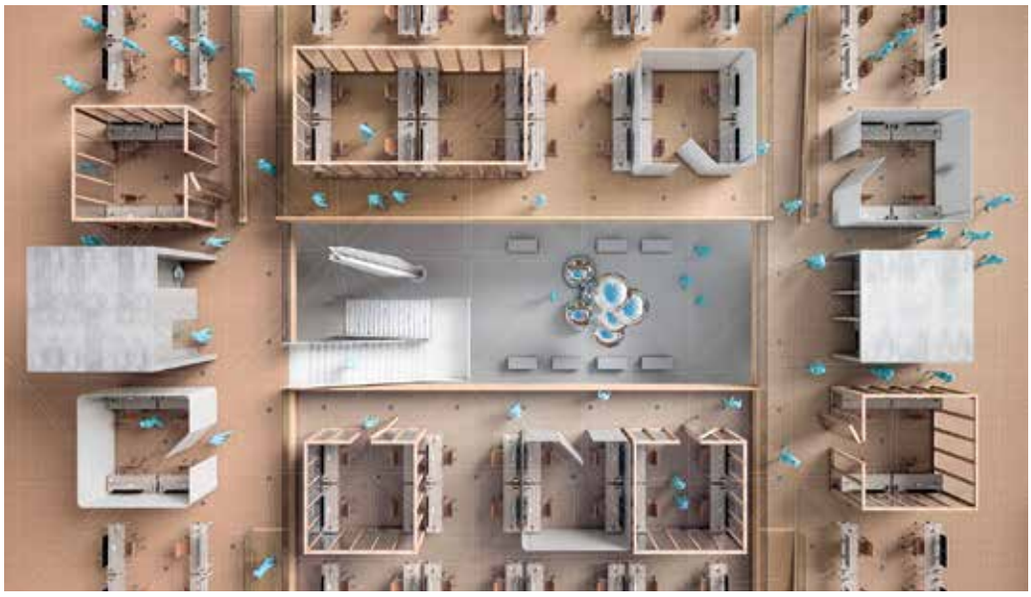
By breaking down the floorplates into parcels, and coordinating them so no team ever has to walk through another team's space to get to their desk, we created a home base that teams can control. Then the layouts of these parcels are such that folks can have a dialogue amongst themselves at adjacent desks in a way that doesn't distract others acoustically. Finally, we've included physical elements in the space positioned in such a way to prevent the visual distractions that break focus.

In this way, the design was driven directly by data our UX teams collected over the years around what breaks focus, how long does it take to get focus back, and how much conversation occurs throughout the day and when. Ultimately, we wanted to ensure team members had options at the desk level to control their space for their desired level of focus.

What was the aesthetic approach you took in these spaces?
Over the course of Bay View and Charleston East, we developed six aesthetic attributes for all of Google's workplace projects, which are also applied here. They are: Natural, Residential, Localized, Culture, Workshop, and Effortless.

"Natural" means that we are introducing elements of biophilia into the space, both from a materiality standpoint and an experiential standpoint. "Residential" means that instead of a monolithic design statement, we wanted something varied and visually textured. We wanted the interiors to feel warm, welcoming, and collected over time so as to appeal to the human spirit. "Localized" is about ensuring the design of the spaces is truly grounded in the community where they're located. That happens at Bay View and Charleston East through the application of biomes.

Below: One of several central courtyards at Bay View shows the generous volume of space and the two primary floors.



We looked at different biomes that naturally exist on the peninsula between the Bay and the Pacific Ocean and used those as inspiration for various sections within the buildings.

"Culture" is about making sure there is an expression of Google in the spaces that's relatable, and also serves to remind people they are part of a much broader culture that is truly global. "Workshop" refers to the sense that Googlers like to tinker, so wanting to make sure the building didn't feel overly precious or prescribed. Folks can take control of their environment and personalize it, rather than feeling like the spaces must remain in their pristine form. The last attribute, "Effortless," is a little harder to describe, but it relates to our belief that often the most beautiful designs come from a simple, clean approach where things are left in their pure, unadulterated forms. Ultimately, we wanted things to feel natural and intuitive, so the building seamlessly reveals itself to people as they go throughout their day.

What can Bay View and Charleston East teach us about the future of workplace design?

Standard workplace design today is often coordinated to within an inch of its life. Furniture, lighting, and floor cores are aligned in such a way that if you move anything, it becomes a construction project. Here, the building systems are completely agnostic of desk layouts and able to convert over time. We were driven to think long and hard about what "adaptability" truly means and how to build systems to support it.

As we move into a more hybrid future of work, time will tell what "work" actually means and what people need when they come to the office. Those needs may be very different than they were pre-pandemic, and some of the final solutions at Bay View and Charleston East will likely continue to evolve to support a more hybrid work environment. But this embrace of inevitable change really drove the design of Charleston East and Bay View interiors. We don't know what the needs for users of these buildings will be in five years, and certainly not in 20 years. But we put a lot of work into ensuring these spaces can truly adapt to the unknown by being able to evolve over time.

Above: A cross section shows interior space planning.

Opposite page, top to bottom: Space planning of team neighborhoods that blends flexible desk space with conference rooms; a focus on incorporating natural materials and designing privacy to meet team needs; flexibility means creative structures that can be easily moved over time.

Following spread, clockwise from top left: A tea lounge concept at Bay View; a branded visitor entrance; the visitor lobby at Bay View; the marketplace cafe at Bay View with reclaimed wood cladding from salvaged redwoods.


Google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From the Ground Up at Google

Jeffrey Curry
Director of Construction Process Controls

"Bay View and Charleston East are really just the tip of the iceberg of what the construction industry can do in terms of sustainable design and construction."

Opposite page, top to bottom: Installation of the strand jack motors onto the top of the canopy columns for hoisting the canopy steel into place at Bay View; ironwork installation of the large canopy beams at Bay View; Jeffrey Curry on-site during installation of ConxTech modular steel to create the floor of level two at Bay View.

What is your role at Google, and how did that evolve over the course of Bay View and Charleston East?
Today I am director of construction process controls, which is part of the global development team within Google's real estate and workplace services group. I serve as a lead managing our architectural relationships for ground-up projects, working closely with our internal design teams to improve the management of the design process across our portfolio through our internal design-build resources.

In the early years, Google was perfecting being a hermit crab: renewing, refreshing, and bringing new uses to existing buildings to meet our specific workplace needs. Now our division is challenged by leadership to bring Google's innovative approach in entrepreneurship to the construction industry. It was exhilarating to be at an organization that fosters that change, by partnering with people in the design and construction industry who all share that forward-looking approach.

Now I support various development teams to give governance and guidance on Google's vision and dynamics of balancing aspirational design, performance, and delivery goals.

Can you describe the early process of working on Bay View?
The ground lease for Bay View was signed back in 2008, and through a new lens we saw the opportunity to do a new office complex there. From the start, the project was planned as an integrated project delivery (IPD) model, meaning we wanted and needed to collaborate early and continue that collaboration throughout the process. Because of that, we needed to get everybody on board with the shared vision right from the start, so people knew what they were delivering and why. That

way the project vision, or charter, could continue to be the North Star as decisions came through the pipeline. We were learning what that meant, as we evolved from being the hermit crab to actually being the constructor of our own domain. The whole time, we were looking at opportunities to push the needle toward using more cost-effective technologies to improve the environment for construction workers and the eventual building occupants – looking at the whole ecosystem of construction and how we might optimize the process.

What was the original vision for Bay View and Charleston East?
One of the primary drivers was always the user experience and asking, "Who are we building for? How do we allow them to do their best work?" The culture of Google is the foundation upon which we build, which has a lot to do with principles around health and productivity of employees, and delivering transformational building environments. Again, balancing aspirational design, performance, and delivery goals.

There was also a vision around entrepreneurial innovation, and maintaining that commitment of sharing resources and information to drive innovation. We've also taken the environmental stewardship of Google and applied it to our buildings. Bay View and Charleston East are really just the tip of the iceberg of what the construction industry can do in terms of sustainable design and construction.

The last piece was considering Google's footprint in a human-focused sense. When we come into a community, what is our impact? How can we become a better neighbor within the community? Now we're expanding beyond Bay View and Charleston East to think about mixed-use redevelopment and how we can change

Below, left to right: The first "smile truss" for Bay View is assembled at Schuff Steel's facilities in Stockton, California; a truss is lifted into place at Bay View.

Above: Bay View is captured in the reflection of the stormwater retention pond.

the paradigm by partnering with the community and hearing their needs. We can't solve everything, but we can do our part to shape a better outcome.

Now that the buildings are coming to completion, how are they solving the challenges set out in that original vision?
For user experience, as soon as you walk into the buildings, you feel there is a fundamental shift in how the program is organized versus a typical workplace. In the past, in the spaces we inhabited, it was always a question of how to manage the proximity of amenities and individual workspaces. In most of our buildings, the close proximity between them was both a blessing and a curse. At Bay View and Charleston East, we've separated the predominant workspace from the amenity functions. That was a fundamental move that answered our charter.

Another key charter for us was flexibility, in terms of a pliable, adaptable building. This led to exploration of a lightweight, longspan structure, which manifested in the canopy concept we have now. Within that, we needed to balance the priority at scale, and keep focus on the user experience. For example, how do you get daylight into the center of these large building footprints? How do you provide more universal accessibility? How do you navigate internal wayfinding? How do you heat and cool under the canopy volume? These questions created opportunities for innovative thinking.

It was also important to provide replicable solutions. For example, the project charter listed the inclusion of photovoltaics. To integrate the PV panels onto the canopy structure, we had to answer a number of questions about how to manufacture and produce them. Key was finding a willing supplier to evolve and meet the challenge. The scale of the two campuses hopefully helped give an impetus to a supply chain for a new PV product in the long run. We wanted to invest in certain things, like the PV panels, to get the larger industry jump-started and help demonstrate how innovations can happen.

And then there is the community aspect, which was turning the focus outward to have a positive influence on the communities where we build. At Charleston East in particular, there are spaces in the building where the public can enjoy a coffee

or community event, even relax and take in the architecture from the public plaza on-site. Beyond this project, we've worked with the City of Mountain View on improving bus and shuttle stops as we promote more sustainable transportation. Charleston East is the first pebble dropped in the water, moving toward a larger ripple effect of the vision for North Bayshore as a more complete neighborhood.

Speaking of ripple effects, what are some other scalable aspects of this project? How can the mindset developed here be applied to other projects?
It's really about showing your partners and collaborators that you are willing to engage in a discussion beyond business as usual. For us, when we were interacting with contractors, designers, engineers, and others, we always tried to recognize their abilities first, then ask them to take it further in manageable ways. We have to ask these questions if we're going to move the needle within the construction industry. Some scalable aspects of Bay View include: increasing modular construction (electrical rooms, meeting rooms, phone rooms), geothermal at new scales, innovation in PV design, a permitted wastewater system, waste diverted from landfill, improved total number of products vetted for Red List ingredients, and landscape designed not only to advance water stewardship, but also to create valuable habitat for threatened wildlife.

You don't have to innovate on everything, but instead build on the knowledge you already have. Innovation happens by executing opportunities. For example, the strand-jacking technique used to raise the canopies or the geothermal system at Bay View. We didn't create these things, but we optimized them. Innovation happens by executing opportunities.

Below, left: A construction worker assists in the strand-jacking of the canopy at Bay View.

Below, center: Bay View is staged as the canopy is strand-jacked into place.

What are some key takeaways for you on this project? How has it affected your personal practice?
A big thing is the value of having good people around you. I've been fortunate to have great team members who have really been a rock, making valuable contributions to moving the projects forward. Another takeaway is around communication, and the value of understanding roles and responsibilities within a team. There's a magic that happens if you respect people, give them a voice, and hold them accountable.

The last thing is the importance of always being able to convey the larger vision of what we're trying to achieve together, and using that as a lens for answering any questions that might come up along the way. Design is problem-solving, and at the end of the day, we always have to answer: What are we solving for?

What do you hope will be the takeaways for the larger industry?
I hope it will show that you *can* do a sustainable design at scale, in the environment where you're located. You *can* push the envelope, if you have partners who are willing to help problem-solve. It's about engaging, then listening and learning.

The other piece is, no matter the scale, it's important to understand how you can minimize your impact on the environment and the community. There has to be a partnership with the community to understand their issues and needs. We can't design in an insular way anymore. We have to turn outwards and think about how we're adding a benefit to the community, whether that be economically, ecologically, or socially.

Below, right: The base of the "volcano" that houses elements of the central plant at Charleston East and helps blend it into the landscape.

The Next Evolution of the Workplace

Chris Alwan
Director of Corporate Real Estate Development

"I think the industry will continue to find ways to implement these things moving forward. It's really about designing from the inside out – desk first."

Opposite page, top to bottom: Chris Alwan gives a tour at Charleston East; construction workers on the roof at Bay View ahead of solar installation; structural framing of the canopy nodes, the most complex part of the project where every element comes together, from structure to services to waterproofing.

When did you join the project, and what is your role on the team?
I started working on the project in January 2015, as the Charleston East project lead under John Igoe. Since then, and through construction which began in 2017, my primary role has been to lead the Charleston East team and deliver the project to completion.

How does Charleston East weave into its context?
The City envisioned the area containing Charleston East as an active, mixed-use corridor. Eventually there will be residential and retail mixed in with office space in this district, with the overarching idea to transform it from an office park into more of a community. That informed Charleston East and the inclusion of retail and public space in the design. Here we have a neighborhood partnership center, plus external amenities including a public plaza. Charleston East is going to be the start of a new kind of community engagement in Mountain View.

We're on a 18-acre site – it's massive. Running around and through the site is an internal block-to-block pedestrian campus loop, called the Green Loop. As it crosses Shoreline Boulevard, the trail will split and go around the building on the left and right sides, then tie back together on the other end, eventually connecting to a public park. The public can navigate all the way around the building, with lots of seating areas throughout. We're bringing back native plant and tree species along the loop, including native oaks and pollinators.

Can you describe the general program of Charleston East?
What's unique about the layout of this building is that, typically in a workspace, you would see a mix of program elements throughout. Things like conference spaces, desk spaces, and amenity spaces would be mixed together in various configurations. At Charleston East, we were able to separate the high-activity

spaces – conference rooms, kitchens, amenities – and locate those on the first floor, with the desk space on the second floor. Level two is the heads-down workspace, and then there are a series of "courtyards" which give quick, easy access down to amenity spaces below on level one. The courtyards become a type of multipurpose area which teams can utilize as a multipurpose, flexible space.

There was an idea that on the second level you could have a space that's always evolving with pop-ups and a flexible separation of spaces. That translates to a couple of different kinds of partitions and workstations, all of which are reconfigurable. This emphasis on flexibility and empowerment to make what you need is antithetical to typical workplace design.

At the same time, even though the second level is completely open and flexible, we have an emphasis on team space. A typical team space here might be roughly 10,000 square feet, and you could put about 50 people in that space. As teams grow – which they always do – they'll be able to grow into adjacent areas. They'll have connectivity both visually and physically, being able to expand out and grow their neighborhood, while still being connected to teams on the same level. We're trying to give people the opportunity to connect in places they might not normally, rather than segregating teams into different buildings. There's a lot of magic that can happen just by giving people adjacency. And not just adjacency to team members, but connection to the outdoors, to natural light. At virtually every point in the building, you'll have a 360-degree view outside to sky and trees.

From your perspective, what are the key definers of Google's workplace that took root here and signal the future of the workplace?
We're testing things here. We took a lot of concepts Google was working on and applied them here in a simpler way. For example, separating workspaces from high-activity amenity spaces, and also things like access to daylight, finding unique ways to bring the outside in, acoustics. I think how we organize our workspaces in the future is going to be heavily influenced by what we're doing here at Charleston East and at Bay View.

Thermal comfort is something we've always focused on – the ability for workers to control the air around them. Here, we've put the workspaces on a raised floor. This gives you the ability to bring air from underneath and move the diffuser around. So

Below, left: An early rendering showcases a potential layout for one of the courtyards.

Below, center: Depiction of an activated central bay of the human scale. By providing a kit of parts of customizable partitions, the office space takes on the human aspect of its varied occupants.

if the diffuser is in this individual tile, I can pick it up and move it here or there. If I'm sitting here and the air is too cold, I can move the diffuser over there. It gives a level of control versus a typical office, where the air vents are overhead and static. We've also untethered things like power and data access. It's not a new concept, but having the raised floor gives us a lot more flexibility and helps us meet performance requirements. I think the industry will continue to find ways to implement these things moving forward. It's really about designing from the inside out – desk first.

And yet, that desk-first process did yield such a visually engaging design.
It goes to show that it's possible to do both. But starting with the worker and that human-centric motivation was always most important on this project. It shows you can start there, and still end up with something visually dynamic. You're sitting here inside, in this volume, and it feels incredible. And if we can do it at scale and economically, maybe not in exactly the same way next time, but I do think that's the next evolution of the workspace.

From your perspective, what were the key factors that allowed for the level of innovation that was achieved at Charleston East and Bay View?
Having design principles and performance standards that the team could anchor themselves around was really important. It grounded everything we did. It brought a lot of wild ideas back to earth, and at the same time allowed the space for people to imagine and aim sky-high.

And, of course, bringing in really smart, creative people who are excited about working on a project like this because of the purpose behind it. It was as though everyone's imagination was allowed to be unleashed, and that energizes and drives the whole team. We created a balance – between people like that, who are forces of nature, and people like me, who are figuring out how to make wildly creative ideas happen with the tools and resources that we have. It was a collaboration of people with all different skill sets and viewpoints, but who were genuinely excited to talk about the design for months and years.

What was different about the communication and feedback loop on this project versus others you've worked on?
We know that all team members are dependent on one other – architects depend on the engineers, engineers depend on the contractors, and everyone depends

Below, right: An early visualization shows an interior concept for one of the many internal courtyards.

Above: "Tube net" steel is in place as work on the roof is advanced at Charleston East.

on the project management team to help facilitate things. Here that was openly acknowledged and encouraged in a way I haven't seen before. It was a massive team effort.

We often see designers who like to hunker down and develop ideas to a point where they're presentable. Here we tried to push the pattern of interaction in a different way. Instead of waiting for designers to feel ready to present, we told them we wanted to see what they were working on *now*, because perhaps we could cut their workload and help them get focused more quickly. The perception is often that the client is going to slow things down, but we actually wanted to speed things up. We knew that having designers be in collaboration with us in real time was going to be a benefit. It was challenging at first, and it took some time for people to trust one another. But once trust was established, it just started working.

Can you give me an example of what this collaboration yielded on Bay View and Charleston East?

The building's steel canopy is what we refer to as a "tube net," because it's a net made of tubular steel. This isn't something you can assemble in place – it has to be built on the ground and then lifted up. And it's a massive amount of weight, so this structure system has to support everything on top of it and everything that's going to land from above. There's a level of deflection that happens in this system, first when you put up the steel, and then when you put every other layer on top of it. This required an extraordinary level of coordination between the engineering team and the construction team, because the engineers can tell you how much it's going to deflect and what size steel to use, but then the construction team comes in and tells you how they can actually physically make that happen. All of that influences the design. People know how to put together a typical steel building, but this was not a typical building. We needed that type of feedback loop in order to figure out how to make this happen. When we actually put the canopy together, it went off without a hitch. That was because everyone spent the time upfront, working together to figure it out.

You don't typically hear about engineers and contractors working together to influence the design on a building like this.
It's a different model. Our industry is typically very linear: you design it, you price it, you permit it, then you build it. And then when you price it, after it's designed, you might find out it's too expensive and then go back and redesign to get the cost down. It shouldn't work like that. It's one of the most archaic systems left in the country in terms of production. Design-build is one delivery model that's been around for years and it gives the opportunity for a contractor to work directly with a designer to come up with a design that is both buildable, and meets the budget. Putting all of it in one house helps lower the risk, and gives everyone more ownership of the outcome.

What do you hope this project will mean to the wider industry?
I hope it will help people take risks from a sustainability standpoint because we've shown here that these things are not actually that risky. For example, take the solar panels. We've shown it's possible to make PV panels not only a key element of the architecture, but also produce a huge amount of the building's electricity. That's a huge win. If we're able to give other people comfort that these types of sustainability initiatives can be done, that's important.

When you focus on the people, the environment, and the community, and really clarify those priorities, this project is a good example of what you can achieve. Hopefully, we're making it easier for everybody else to do these things, too. It's about enabling others.

Below: A photo of Bay View by Iwan Baan shows the rich avian ecology of the San Francisco Bay.

A Conversation on Partnership and Collaboration

Yayu Lin, Sares Regis Group Northern California, Chief Operating Officer
Damon Ellis, Whiting-Turner Senior Vice President

"We invested a lot of time and effort into creating and nurturing a transparent, collaborative, and supportive team culture."

— Yayu Lin

Opposite page, top to bottom: Bay View team members walking down the bike ramp into the lower level; pouring of concrete at the site; team collaboration captured between Gavin Lauer of Whiting-Turner (left), Yayu Lin, and Josh Allen of Schuff Steel after the first "smile truss" was lifted into place.

When did you each join the project, and what are your roles on the team?
Damon Ellis: I've been on the project since late 2015. My role has been project executive for Whiting-Turner, who is the general contractor on Bay View. Whiting-Turner fielded a team of engineers, project managers, superintendents, and safety professionals who were responsible for hiring the trade partners and safely building the project, in collaboration with the design team.

Yayu Lin: I joined the Bay View project in January 2011. I am with Sares Regis Group of Northern California, Google's development manager for the project, and we function as an extension of the owner's team. We were the first to be hired by Google, and we helped select the project team for Bay View. From the start, it was imperative to assemble a team that embraced the collaborative nature of the project and had the unique willingness to innovate.

Tell me more about those key factors you used to select the Bay View team.
YL: We knew Bay View was one-of-a-kind. We were being challenged to build something that's never been done before. We also knew that Google was committed to innovating in a big way. We created a project charter for Bay View back in 2015, and wrote down that our desired outcome was "a structure that would push the boundaries of building technology, connections to nature, and what a corporate campus can be."

We knew we needed to find project partners who would be open-minded and instead of saying, "No, we can't," would say, "How can we do it?" We assembled a team of talented, curious people who were committed to collaboration and innovation. We all saw Bay View as an opportunity of a lifetime to achieve something greater than ourselves by working together and propel our industry forward.


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Damon, what were your first impressions of the project?
DE: We'd been shown a rendering of the project early on, so we knew the buildings were going to be extremely unique and challenging to design, engineer, and build. We also knew that Google's desire was to leave no stone unturned in terms of assessing what was possible on the project using technology, prefabrication, and innovation. In many ways, those challenges are what get us out of bed in the morning. It's why we gravitate towards working on projects that no one has ever done before.

When we joined, there was an existing team already working on Charleston East, and Google asked us to collaborate heavily with them. Right off the bat, there was a high value placed on having an integrated team.

How did the goals and values of this project compare to your previous construction projects?
DE: We knew Google wanted to push the envelope on sustainability for this project, particularly with healthy materials, energy efficiency, and water. But we also knew we needed to temper this desire for an innovative building with the realities of cost and schedule, so we did a lot of heavy lifting early on to balance out those priorities and figure out how to execute on them. We were familiar with all of the sustainability goals in terms of metrics and certifications that Google was targeting, but we took things to the next level here.

For example, with healthy materials, we spent a lot of time early on with the design team and the Google team to dig deep into the supply chain and understand the component parts of all the materials we were using. There are also code and performance-related impacts for each material you specify, and in several cases, we were helping create mock-ups of assemblies to test and understand how materials would perform. We put in the extra effort upfront to ensure we could deploy the most environmentally friendly materials possible, while also being code-compliant and safe.

What are some of the overarching design principles of the project that stand out to you?
YL: One of our design principles is beauty and simplicity. An immense amount of thought, planning, and coordination went into what people don't see to make the canopy look simple and elegant. As a small example, the canopy itself is very light-

Below: The structure begins to take shape with shoring for the structural slab forming.

Following spread: An aerial view of Bay View and Charleston East.

weight because the vision was for a structure that touches lightly on the ground and provides shelter. Because it's so lightweight, the wind uplift was a factor we had to engineer for, and it took tremendous coordination between the design, engineering, and construction teams to design the four anchor points – we call them "touchdowns" where the canopy touches the ground. What people don't see is that underneath each touchdown, there is a 54,000-pound steel tie-down column core filled with concrete that anchors the canopy. This is just one example of many on the Bay View project of the interdisciplinary collaboration that took place to make Google's vision of "beauty and simplicity" a reality.

It sounds like many of the key innovations on the project were developed out of a close collaboration between team members from different disciplines.
DE: Yes. I think about the geothermal system, for example. I was involved in one of the first conversations about geothermal on the project, which took place at Google's R+D Lab. I was standing with Google folks, two mechanical engineers, and a lead project manager talking about how we could really take the mechanical system and the heating/cooling of the building to the next level. We knew a heat pump solution, which Whiting-Turner had just successfully used on a major central energy project at Stanford, would be about 60% more efficient than a typical office building system, and we wondered how we could make something even more efficient here. We were discussing the footprint of the building and knew the structural engineer would require us to put pilings underneath the building to hold it up. That's when we wondered: Could we put geothermal tubing in the structural piles of the building? It's a testament to the magic of creative solutions – it's often simply about getting a group of smart, creative people in the room and talking.

YL: There were many innovations on this project at all levels, from creative design thinking to figuring out a smarter way to build in the field. We were pushing ourselves to innovate *everything*. For example, healthy materials were an important aspiration and required commitment from designers, engineers, and subcontractors alike to find the right materials that met the performance, sustainability, and health criteria. Through the construction process at Bay View, we vetted over 3,000 building materials, from the CPVC pipe in the ground that a Googler will never see to the plywood walls that a Googler may touch daily. Now, we are proud to have a body of work on healthy materials that will benefit future projects and the industry.

Efficiency, which was another one of our design principles, also drove a lot of multidisciplinary innovations across many aspects of the project. Before we started construction, we identified project components that could be built off-site and optimized for prefabrication and modular construction as much as we could, which we believe increased efficiency, reduced the field activities, and made for safer working conditions on-site. At the peak, we had over 1,100 contractors on-site daily at Bay View. I'm proud of the stellar safety record we've achieved on this project.

It seems like the human-centric vision behind this project informed every aspect, through design and construction.
YL: On a megaproject like this, it's very easy for challenges to arise because inevitably there are conflicting priorities and difficult trade-offs with each decision. That's why from the beginning and continually throughout the project, we invested a lot of time and effort into creating and nurturing a transparent, collaborative, and supportive team culture. I think anyone who worked on Bay View will attest that we have a great team culture. With Google's leadership, we established a foundation of trust and mutual respect so we could rely on each other's expertise to conquer challenges and build something that has not been built before. Personally, the friendships and connections I've made on the Bay View project have been the most fulfilling part of my experience, and the most valuable lesson that I will take with me to all future projects and teams.

Creating Shared Value

Joe Van Belleghem
Global Development Senior Director

"Whenever you are unlocking innovation, it brings questions of how you are aligning with the community and getting support from agencies to enable it."

Opposite page, top to bottom: A rendering of the prefabricated, modular corporate accommodations at Bay View; trees are grown at Google's nursery in Santa Clara County to provide more mature, native plantings; Javier Gonzalez, head of policy in California, and Joe Van Belleghem pictured on a community walk as part of community outreach around Google's Downtown West master plan in San Jose.

In your own words, can you describe what you do at Google?
I'm the senior director of Google's real estate development team, managing those who are responsible for designing and delivering our ground-up office developments and mixed-use districts.

What were the original development goals for Bay View and Charleston East, and how did those evolve?
I joined Google after construction had commenced, and the primary focus at that point was on construction execution for the project and ensuring we could deliver on the environmental performance goals. With Bay View, there were goals around geothermal energy, being water positive, and showing how to innovate in new ways of building. For me, whenever you are unlocking innovation, it brings questions of how you are aligning with the community and getting support from agencies to enable it. The team did a remarkable job working with all of the relevant agencies for many first-of-their-kind strategies.

I think of innovation in several buckets. One is to do with physical things – for example, the geothermal, the wastewater treatment system, the dragonscale solar roof system, the structural innovation of the canopy at Bay View. These are all examples of physical innovation. But there is also innovation around how you do the work, and how you interact with others to create a shared value that is different from traditional processes. For instance, this project taught us a lot about our strategy for approaching the design and build of future projects, which led us to the design-build model. This model ensures everyone is aligned on the constructability of innovation upfront in the process, rather than resolving design issues during construction.


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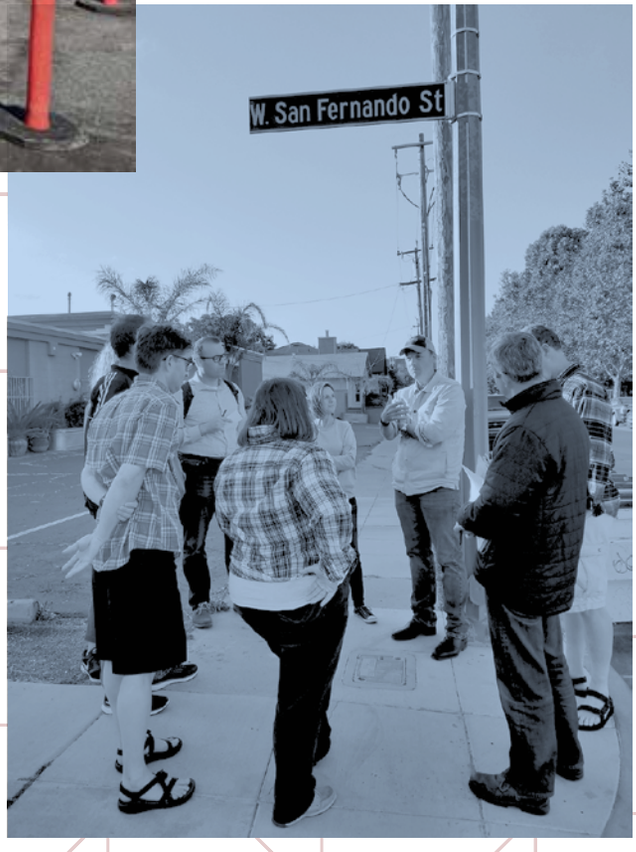
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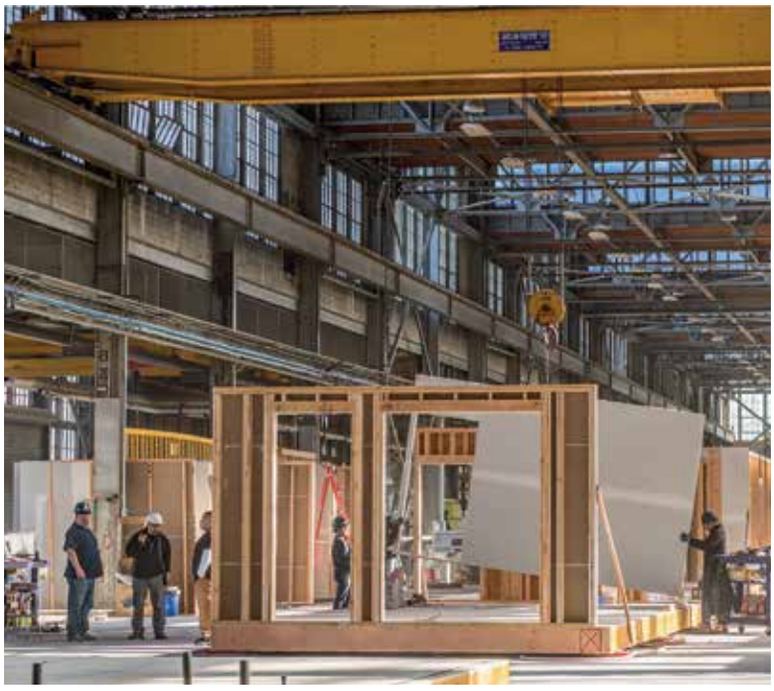
Further, we greatly value the individuals who build our projects. Skilled workers, focused on safety, lead to better outcomes for our projects. To me, innovation is also about building relationships and doing what we can to create an environment that supports productive, safe, healthy workers. It's an innovation mindset of creating a shared value among all partners so that everyone wins.

It sounds like you were thinking of environmental benefits in a holistic way.
The team worked through many topics to enable us to do the right thing environmentally. It's about demonstrating that you can do well by doing good, but you've got to advocate for it. And you have to challenge the system in a constructive way to realize that we need a new paradigm of how to address climate change through the building industry.

Our mindset is also on how to be a helpful neighbor. That's really important. For instance, when we were looking at the short-term employee accommodations at Bay View, the team wanted to do something modular. We sent a letter to a startup called Factory_OS expressing interest in their modular building technologies, and that initial investment from Google for this project ultimately helped enable the launch of this company, which is proposing modular solutions for creating more affordable housing throughout the Bay Area and beyond.

It seems like there was a big consideration for the larger impact of this project on the people who were physically constructing it.
It was awe-inspiring to watch how these contractors did their jobs on-site. For example, they were instrumental in the effort it took to install 90,000 dragonscale

Below: Thousands of contractors from Whiting-Turner and Devcon and their subcontractors made these projects possible.



Above: Google invested early in Factory_OS, which has allowed the company to offer prefabricated modular housing production throughout the Bay Area.

PV panels. Yes, the panels will have a significant positive environmental benefit, but we can't forget it was those people, those contractors, who helped make it a reality. It's about celebrating the work and effort that went into those aspects of the building.

As a result, we've leaned into programs such as Hard Hats with Heart. This is a partnership with the American Heart Association to create a culture of healthy living through engaging campaigns for our workers on-site. So far, over 3,000 people have participated in programs focused on everything from eating smart to stress reduction, safety training, heart health, and more. It's about honoring the fact that people build the spaces we occupy, and if we can play a role in helping improve their health and well-being, and focus strongly on their safety, that's the most important thing we can do.

It's a ripple effect that can be much deeper and more impactful than just the buildings themselves and the people who will occupy them.
It's spurred our thinking around a systems approach from an environmental impact perspective, too. We are part of the ecosystem. We are not separate from animals and nature. We are all living beings, together. We're so intertwined. And we know that our health and well-being is impacted positively when we are in nature. So we need to find ways to coexist together, and benefit one another.

To give you an example, we've noticed that in Silicon Valley, it's hard to find mature, native trees for our projects because of our scale. We don't want to plant a small tree if we can avoid it, because we want the impact of that experience, both on an ecological and human scale, to be as immediate as possible. So that led us to create a tree farm.

On our tree farm, we're growing native, large trees, mostly sourced from the same regional watershed they'll be planted in. Yes, we're growing these trees for use in our projects, but we're also looking at ways that these trees can be grown in the most environmentally friendly way possible – using renewable energy, primarily PV; reducing water consumption; preserving soil viability by planting in grow-bags rather than boxes on gravel. And we're working with the operator to create high-quality jobs and skills training, including recruiting underrepresented local talent.

“It’s an innovation mindset of creating a shared value among all partners so that everyone wins.”

It’s important to us to think more holistically about what we’re doing, and the net result is that we’re having a bigger impact, earlier. It affects people’s lives positively, it economically makes more sense, and it’s environmentally responsible.

How did Bay View and Charleston East spur your larger thinking around Google’s principles in future developments?
We wanted to create a very innovative office environment for Googlers, while demonstrating leadership in environmental design. As we got into that, we realized we could broaden our thinking to more of that triple-bottom-line mentality of creating great work environments for our employees, creating great environmental outcomes, and also contributing to the community. We asked, “How can we do all of this while also being responsible?” It’s the idea of trying to create replicable solutions, and the mindset that we all need to play our role in balancing environmental, social, and economic objectives.

Now that we’re starting to conceptualize mixed-use developments, it’s opened our thinking around how the entire system works. Because we want places that will not only enhance the well-being of Googlers – before, during, and after work – but will also be places where everyone in the community feels like they belong. We’re asking how these places can have a positive impact on everyone they touch.

In addition, the lessons we learned at Bay View led to us changing to a design-build model on future projects. This provides for better integration with the design and build teams to ensure constructability and avoid waste in redesigning items not traditionally resolved early in a design-bid process.

Why is it important for Google to take a leadership role in the community?
The bottom line is: It just makes sense. But what I’ve learned over the years is that if you collaborate with others, and you focus on solutions that are good for society and good for the environment that make economic sense, you just get better outcomes. It’s about behaving responsibly and doing what’s right. We need to listen to and work with our neighbors on coming up with possible solutions that make better developments that better the community.

Opposite page: A photo of Bay View by Iwan Baan shows the San Francisco Bay in the foreground and the Santa Cruz Mountains in the background, with the building reflecting off the water.

Being a Helpful Neighbor

Ruth Porat
Google and Alphabet CFO

"Great design is never just one thing – it's a holistic, comprehensive, and user-friendly approach. It creates places where collaboration can happen comfortably – whether in person or virtually."

Opposite page, top to bottom: Google and Alphabet CFO Ruth Porat at COP26 in Glasgow, Scotland; a rendering shows the view from Bay View's event center lobby towards the landscape with a NASA wind tunnel in the background; a rendering of the public plaza outside of Charleston East shows the focus on offering community events throughout the year.

What is your personal relationship to Mountain View and the region?
I grew up in Palo Alto, having moved there as a child from the UK via Cambridge, Massachusetts. My dad was a physicist at Stanford's Linear Accelerator Center. One of the main reasons he chose to move my family here was the vibrancy, intellectual curiosity, and aim to do things that had never been done before. Things like building Stanford's atom smasher. That vibrancy has expanded dramatically since the time my dad moved us.

Can you tell us more about what is so special about this place?
The culture of innovation here is infectious and always the topic of the day. Almost everyone has a deeply held commitment to making a difference in the world – that is what motivates us at Google and Alphabet, and I believe it is what motivates many others who choose to live and work out here. There is a drive in the Valley to create the future that we hope to see, and I think that makes it one of the most special places on the planet.

What is Google's relationship with Mountain View?
Since 1999, Google has called Mountain View home, and we foresee ourselves being here for many years to come. Google chose Mountain View for our headquarters because we love everything about being here. We love the beauty of the Bay, the close proximity to universities, the family-friendly environment, and the chance to work in a city in the heart of Silicon Valley.

Many of our employees both live and work in Mountain View, and as a company, we believe strongly in being a good neighbor. Through the years, we have invested millions of dollars in the community, by giving grants to the Mountain View Educational Foundation to support STEM education, funding for the Mountain View Community Shuttle, grant funding to support homelessness intervention and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prevention services, and ecological restoration projects like the Charleston Retention Basin, just to name a few.

And we are very proud that every year, Googlers volunteer thousands of hours with Mountain View-based organizations, including the Community Services Agency of Mountain View, Silicon Valley Bicycle Exchange, Mountain View Schools, and the extraordinary Computer History Museum.

How do Charleston East and Bay View continue this long-standing relationship with the region?
Charleston East is our first-ever ground-up development in Mountain View, and we thought long and hard about how to best put together a project that delivers on the city's vision for the future of North Bayshore. Charleston East rethinks the workplace with intentional design that invites the community in, integrates harmoniously with the natural environment, creates great economic value for the city, and also supports our employees who love living and working in Mountain View.

Since before the pandemic, part of the magic of our Google workspaces has been that these spaces are healthy, sustainable, and functional, with a little bit of "Googley" built in. Great design creates a place where people want to be, which is evidenced by almost half of our global workforce coming in voluntarily once our offices reopened safely. Now, through our ground-up projects, we are able to bring a lot of these commitments and learnings to the local community. We are really focused on how these spaces can engage the community, and build resilience and better health outcomes.

Can you say more about how Google defines "great design"?
Great design is never just one thing – it's a holistic, comprehensive, and user-friendly approach. The approach combines opportunities to socialize, collaborate, learn, and focus. It creates places where collaboration can happen comfortably – whether in person or virtually.

How does this translate to specific ideas informing the design of Bay View and Charleston East?
The motto of Google's founders, "Focus on the user and all else will follow," has guided the design of our offices from the beginning. For this project, there were years of research data and science on what helps employees be their most productive and creative.

Below, left to right: A rendering of the second floor and its village of team neighborhoods; a view showcases how flexible interior architecture allows for focused space within a large, open setting.

Above: An aerial illustration looking north shows everything from the Googleplex to Charleston East, Bay View, and Moffett Airfield.

The first idea we explored was around turning the office inside out – flipping the relationship between focus and collaborative spaces, and their relationship to open versus closed space. It means we are shifting from open desking, which presents challenges for focused work, to enclosed nooks. On the opposite end, we are shifting from enclosed meeting rooms to a wider range of collaboration spaces that are more open and adaptable, based on the types of collaborations the team is doing. Technology is obviously important in those collaborative spaces to enable equal participation for remote colleagues. Having these focus nooks next to dynamic team collaboration spaces means people can quickly transition.

The next idea is around the cognitive benefits of biophilia. We have been working on incorporating biophilic design into our offices for years – bringing key aspects from nature into our offices, such as healthy materials, natural materials, patterns, soundscaping, thermal comfort, adjustable air flow, and circadian lighting. In light of the pandemic and its disruption to the way people work, we are expanding this even more into our other buildings and spaces, particularly our emphasis on healthy air quality.

While some might view these biophilic or air quality measures as an extravagance, there are also financial reasons to introduce more nature and healthy air into the workplace. This is about improving people's lives, and when employees are healthy, happy, and able to do their best work, everyone, including the company, benefits.

How does all of this relate to Google's larger goals around community-centered developments?
Our goal is to have connections and integrate into the local community, with vibrant ground floor spaces that tap into the spirit of the communities where we work and live. We see the long-term value of investing in places that reflect our values, and those of the community.

Building and Operating Sustainably at Google

Sundar Pichai
Google and Alphabet CEO

"We wanted to set an example on sustainability. Here we're doing visible things and sharing everything about how it's done."

Opposite page, top to bottom: On-site solar is added to Google's data center in Saint-Ghislain, Belgium; Google and Alphabet CEO Sundar Pichai; a view inside our Eemshaven, Netherlands data center where Google is leading the race to be the greenest cloud in the industry.

Bay View and Charleston East have achieved some ambitious sustainability goals. What is Google's legacy in this area?
At Google, sustainability has been a core value for more than 20 years. We were the first major company to become carbon neutral in 2007. We were also the first to match our operations with 100% renewable energy. That was in 2017, and we've been doing it ever since. In 2020, we eliminated our entire carbon legacy. Our next ambition is our biggest yet: By 2030, we aim to operate our data centers and campuses on carbon-free energy, 24/7.

What does operating on 24/7 carbon-free energy look like?
This means running every data center and office on clean electricity every hour of every day. Operating 24/7 on carbon-free energy is a step change from current approaches. It means setting a higher bar to never emit carbon from our operations in the first place. We think of it as a moonshot.

First, we have to source carbon-free energy in every place we operate, a harder task in some places than in others. In 2021, five of our data centers were already operating at or near 90% carbon-free energy. In Denmark, we built five new solar farms to support our newest data center, complementing existing wind energy on the Danish grid. And it's operated carbon-free 90% of the time since day one.

Another challenge of 24/7 carbon-free energy is just that: It has to run every hour of every day. In 2020, we rolled out the world's first carbon-intelligent computing platform. It automatically shifts the timing of many computing tasks to when clean power sources are most plentiful. In 2021, we are the first company to implement carbon-intelligent load shifting across both time and place within our data center

network. By 2022, we'll be shifting more than a third of non-production compute tasks to times and places with greater availability of carbon-free energy.

To reach 24/7, we also need to go beyond wind and solar and tap into sources of on-demand clean energy, like geothermal. Geothermal uses consistent heat from the Earth to generate electricity. But it's not widely used today, and we want to change that. Right now, we are partnering to develop our next-generation geothermal power project. This will connect to the grid serving our Nevada data center starting in 2022. We believe our cloud AI, combined with our partner's expertise in fiber optic sensing and novel techniques, can unlock flexible geothermal power in a broad range of new places. Investments like these are needed to get to 24/7 carbon-free energy.

It's also happening right here on Bay View and Charleston East, which have been built to the highest sustainability standards. The buildings will feature a first-of-its-kind dragonscale solar skin equipped with 90,000 silver solar panels and the capacity to generate nearly 7 megawatts of energy. Bay View also houses the largest geothermal pile system in North America, helping to heat the buildings in the winter and cool them in the summer.

What are you trying to accomplish with these new buildings?
We've always, as a company, cared about our spaces. Early on, we had a view that designing great spaces can really affect productivity and culture. A lot about these buildings is making sure we get this right: a nice, open space, nice lighting, things like that.

But as part of that, we wanted to set an example on sustainability. In some ways, you can think about technology as open source. Once you put out open-source software, all of us build on it. Here we're doing visible things and sharing everything about how it's done. I think it will get replicated and adopted, and we will learn a lot.

Obviously, the dragonscale solar panels were a big feature. To me, it's kind of a statement, simply showing that building solar roofs can be aesthetically amazing,

Below, left to right: Google's David Radcliffe (left) on a tour of the R+D Lab as the roof is discussed with Thomas Heatherwick, Bjarke Ingels, and Leon Rost; a team tours the Bay View project as the canopy is raised into place.

delivering energy savings and so on. Overall, it fits the theme of pushing technology and boundaries.

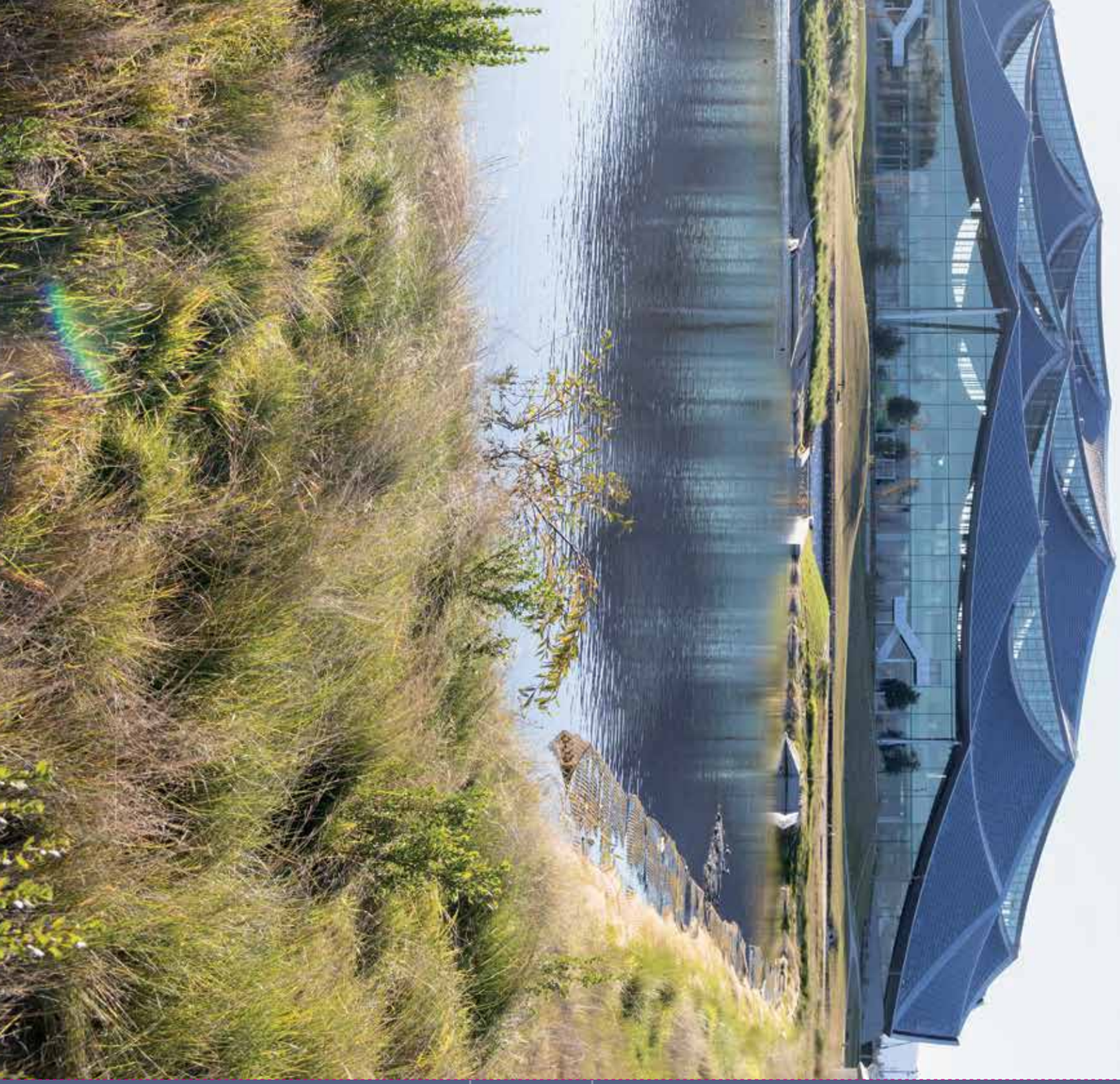
How do you frame the value of this type of financial investment for Google?
First of all, on the most practical basis, I think our employees demand sustainability as a value. We've always had it as a value. It will help us hire the best talent over time. That's one example of a business case.

But honestly, when you work on such technologies, when you do that kind of research and development and innovate, I've never seen a time when that doesn't translate into other benefits for your business. We are using AI to shift loads across data centers. So I just don't see how investing on the tip of the tree of technology innovation is not ROI-positive over time.

Why is it important for Google to take on these big challenges around sustainability?
Today, climate change is the most profound risk we face. One that affects our health, our economies, and our future together on this planet. At Google, we view big risks as both a challenge and an opportunity. In 2020, we committed to help one billion people make more sustainable choices by 2022 through our core products like Google Maps and Search. In all of these efforts, our goal is to make the sustainable choice an easier choice. Individually, these choices might feel small, but when you multiply them together across our products, they equal big transformations for the planet.

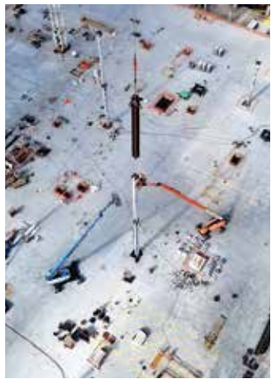
Above: A close-up shows the layers of dragonscale solar, a new product that emerged from a partnership with SunStyle to find a beautiful approach to solar that would also perform throughout the day.

Following spreads: A series of images show views of Bay View's outdoor courtyard; Bay View 200 within its native baylands landscape; a view of Bay View from across the stormwater retention pond.



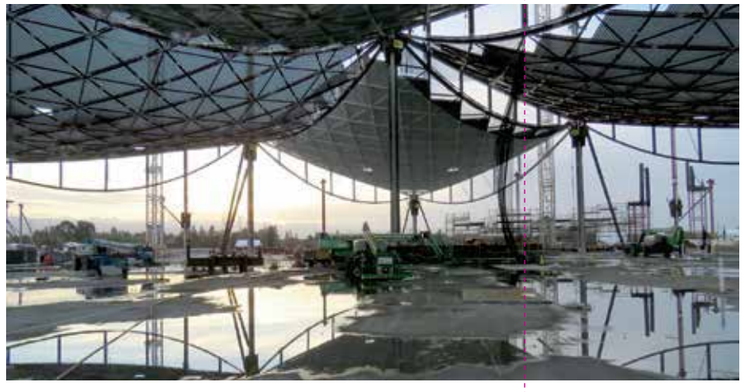
CONTEXT

A timeline shows the progression of construction on Bay View and Charleston East from July, 2017 to March, 2020.



2017

2018



2019

2020

The latest additions to our Silicon Valley campus, Bay View and Charleston East, are places that embody our values: building and operating sustainably, being a helpful neighbor, and designing the best places to work. This was the first time we led the concept and construction of our own major campuses, so the projects were an opportunity to rethink the very idea of an office building, and in doing so, rethink what is possible for the larger building industry. This translates into environments that are not only healthy and high-performing, but integrated with their natural surroundings and adaptable to the future. Across these two projects with four primary buildings, 1.7 million square feet, and 60 acres, we've created a prototype for the workplace of the future: flexible places designed to inspire the next generation of innovation and big ideas.

Bay View

Located on a 42-acre site next to the NASA Ames Research Center and Moffett Federal Airfield, Bay View is an all-electric and a Living Building Challenge (LBC) water-positive campus. It is on track to be the largest project ever certified by the International Living Future Institute (ILFI) under any of its programs, which are recognized as the most ambitious regenerative building rating systems in the world. Bay View consists of a constellation of three buildings, each featuring a lightweight canopy structure optimized for interior daylight and views totaling 1.1 million square feet, with 20 acres of open space. Two buildings contain office space totaling 4,300 seats, one building at 600,000 square feet and the other building at 400,000 square feet, each with large, flexible, and interconnected workspaces across two levels. The third building is a 100,000-square-foot, 1,000-person event center. Adjacent to the primary development, there are 240 prefabricated modular spaces serving as short-term employee accommodations.

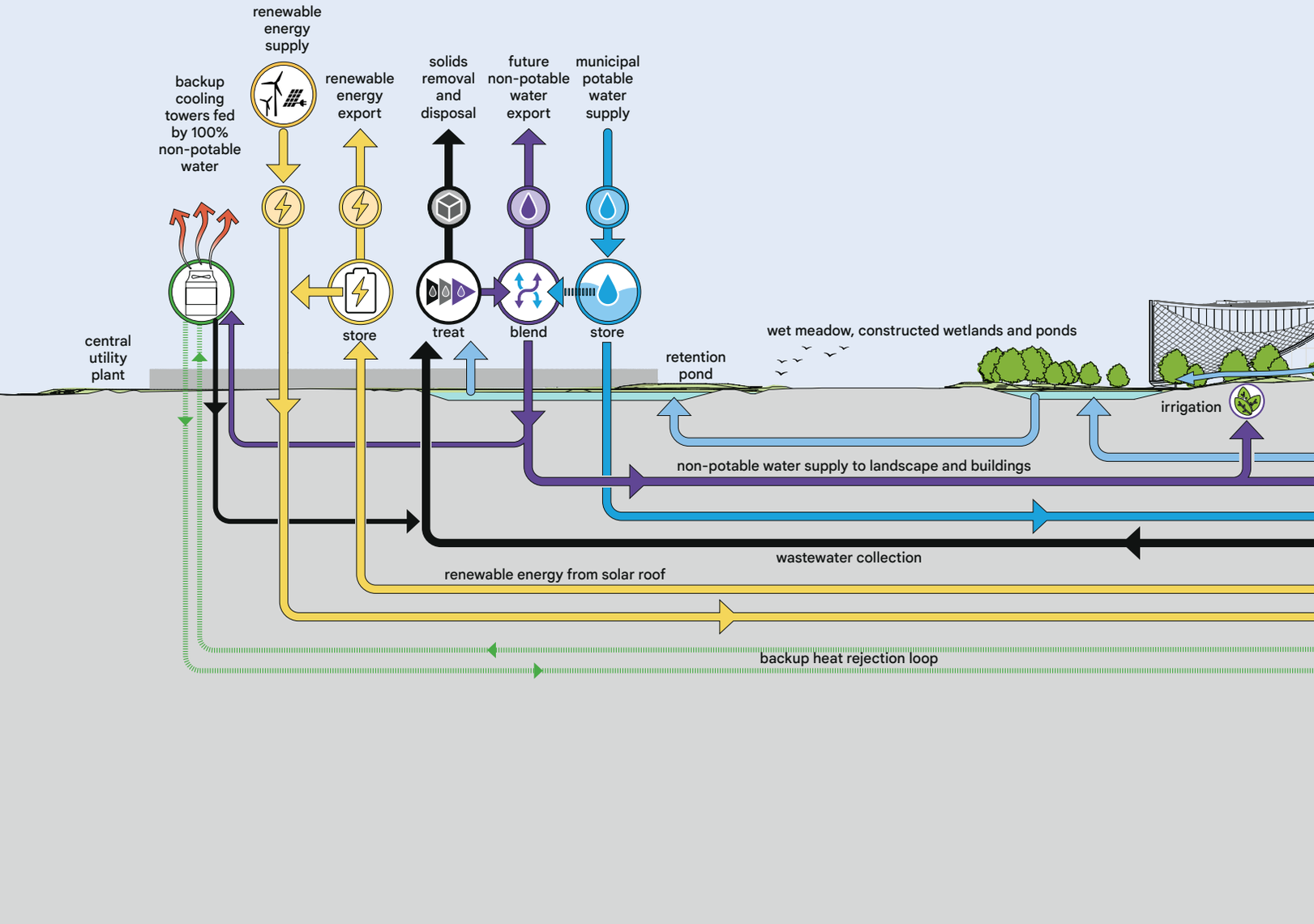
Left: An aerial view of the Bay View campus shot by Iwan Baan.

Bay View Details

- On track to achieve LEED-NC v4 Platinum certification.
- On track to be the largest facility ever to attain the International Living Future Institute (ILFI) Living Building Challenge (LBC) Water Petal Certification.
- All-electric campus that, when combined with power from nearby wind farms, operates on 90% carbon-free energy.
- 50,000 integrated solar dragonscale panels generate nearly 4 megawatts, approximately 40% of the buildings' annual energy use.
- Largest geothermal pile system in North America to heat and cool the buildings, estimated to reduce carbon emissions by almost 50% and water used for cooling by 90%.
- 100% outside air system with underfloor air system, overhead displacement ventilation system, and radiant systems on level one in perimeter zones.
- Diverted more than 85% of construction waste from landfill.

- Sourced and reviewed all materials following LBC's Red List requirements for healthy materials.
- Net water-positive campus, meaning all non-potable water demands are met using recycled water generated on-site with the potential to export excess non-potable water.
- Stormwater collection ponds where water can be drawn down, treated, and combined with treated wastewater from the buildings to create an on-site non-potable water source.
- 35% of the site is dedicated to promoting urban agriculture through native pollinator habitat, demonstration garden beds, and bee boxes.
- 1,000-person event space for Google-hosted functions includes an auditorium with one of the largest screens in the U.S.
- Improved connections to existing San Francisco Bay Trail.

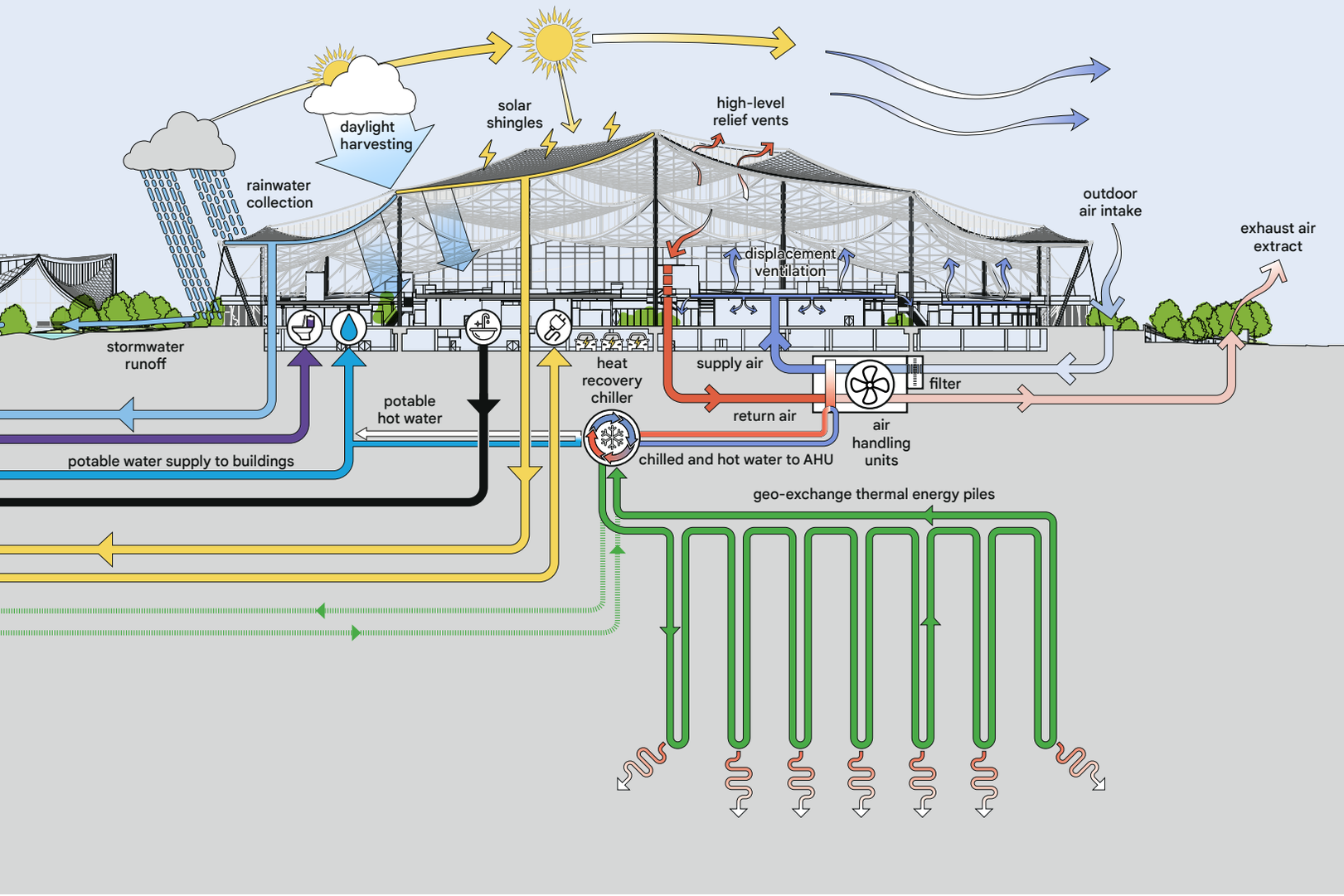
Above: A photo by Iwan Baan of Bay View 100's second floor and expansive, "tube net" canopy.



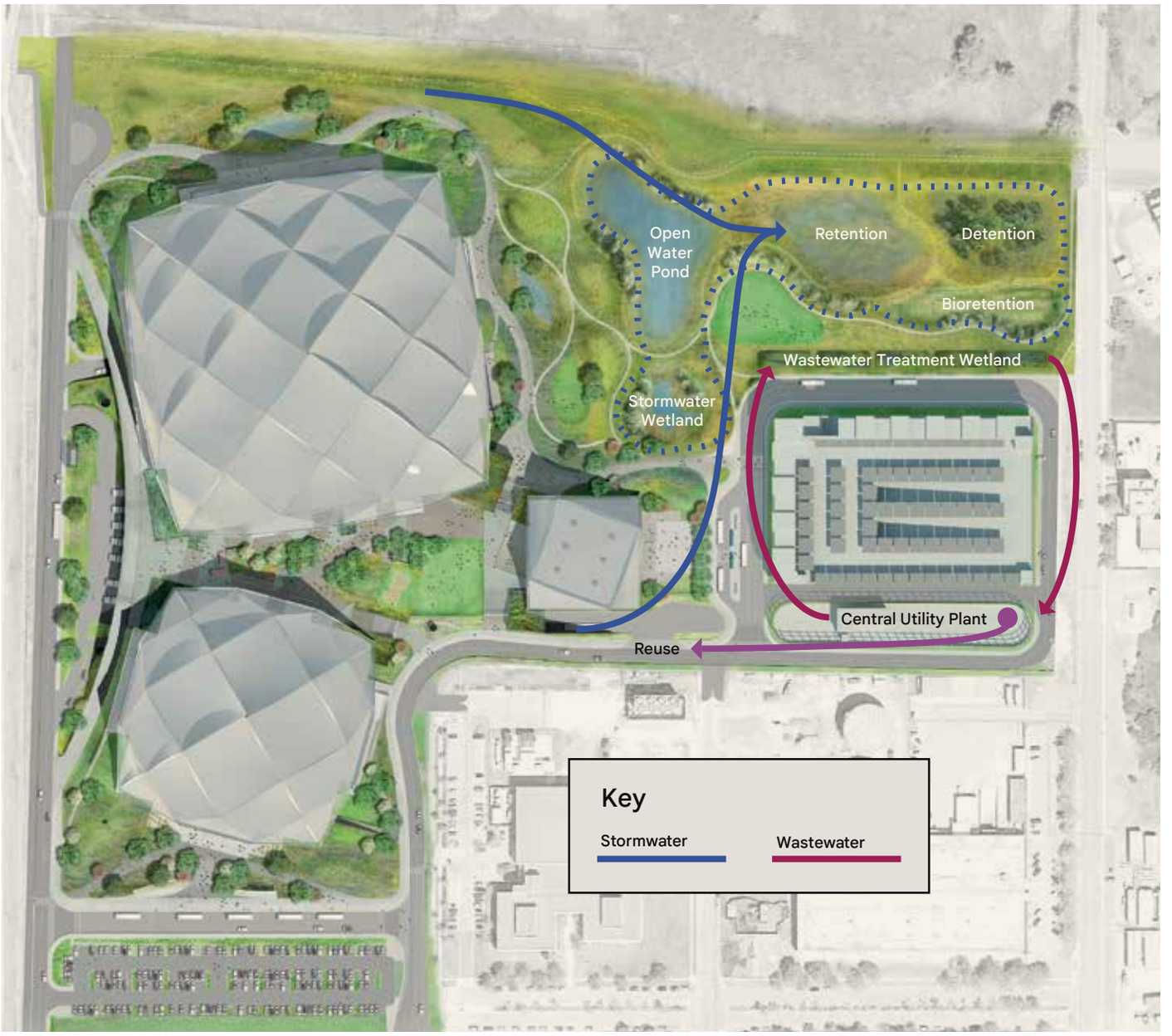
Integrated systems

At Bay View, we took an integrated design approach to the building systems and technologies, thinking carefully about how to link them with the water moving through the site. The buildings' unique canopy design was carefully engineered to capture the maximum amount of rainwater and solar energy. The all-electric buildings are powered in part by a first-of-its-kind dragonscale solar skin, which when combined with power from nearby wind farms, will make Bay View one of our first campuses to operate on carbon-free energy 90% of the time.

Above ground, the buildings link to a self-contained stormwater catchment and reuse system. Below ground, a massive geoexchange field is integrated into the structural system. Of the 3,900 structural piles holding up the buildings, 2,200 are used for geothermal, utilizing the thermal mass of the Earth to heat and cool the buildings. This reduces the amount of water typically used for cooling by 90%, equating to 5 million gallons of water annually.



Above: A diagram by Ed Garrod from Integral Group showing how energy and water move through the Bay View campus.

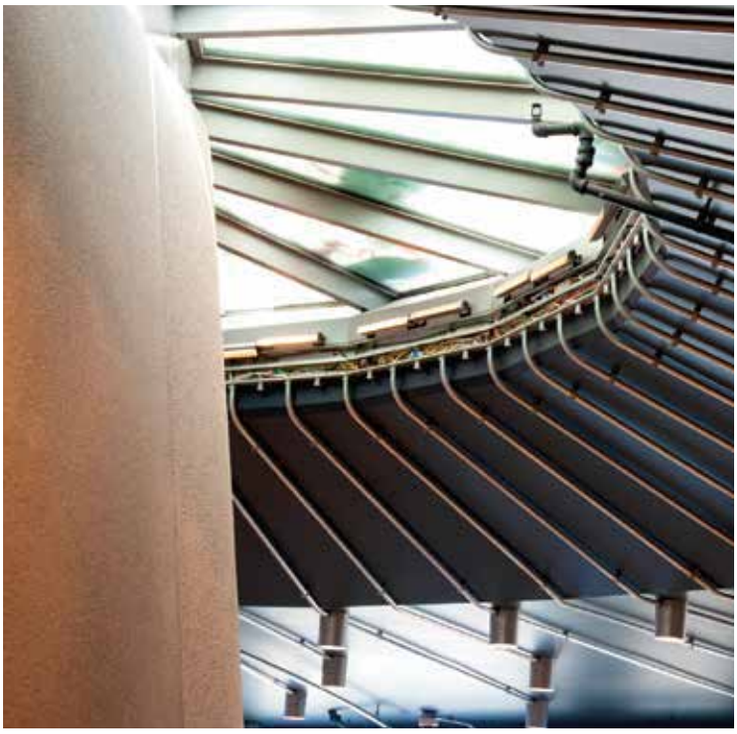


Water System

Bay View's adjacency to the San Francisco Bay makes water an important focus for the project. The buildings use natural and engineered techniques to save on water consumption while also preserving the neighboring ecosystems. We collaborated with water and ecology experts to build an on-site system that collects, treats, and reuses all stormwater and wastewater. A series of above-ground ponds gather rainwater year-round, connecting to our treatment system where it combines with treated wastewater from the buildings to serve as a water source for cooling towers, flushing toilets, and landscape irrigation. All non-potable water demands are met using recycled water we generate on-site.

Bay View is on track to be the largest project in the world to achieve LBC Water Petal certification. It's a key step toward achieving our companywide goal to replenish 120% of the water we consume by 2030.

Above: An integrated diagram showcases elements of the water-positive Bay View campus with stormwater and wastewater treatment.



Energy Systems

Bay View is an all-electric campus. 40% of its annual electricity is generated by integrated photovoltaics. Prioritizing renewable sources of energy, like solar, helped shape the building's form with the sweeping, longspan canopy roof, which maximizes the amount of solar energy the buildings can capture.

Another design driver was reducing the amount of energy the buildings use in the first place. The clerestory windows dotting the canopy establish daylit work-spaces, and a highly efficient HVAC system helps cut down on overall energy use. The integrated geothermal pile system at Bay View, which is the largest in North America, is estimated to reduce carbon emissions by roughly 50%.

Above, clockwise from top left: Overhead lighting conduits at Bay View combine function and beauty; dragonscale solar panels on the canopy; twenty miles of pipe snaked horizontally around the site to connect all geothermal piles at Bay View to the thermal plant; the colorful pump room at Bay View.

Charleston East

Situated on an 18-acre site in the North Bayshore area of Mountain View and adjacent to Charleston Park, Charleston East contains 590,000 square feet of occupiable space. This includes 10,000 square feet of space open to the community, including restaurant, retail, and community event spaces. A large outdoor public plaza with public art and plentiful seating hosts farmers markets, food trucks, live music, and more. Inside, the flexible and adaptable workspace is organized around two levels, giving employees the ability to easily make office alterations. Workspaces are organized around 20 indoor courtyards.

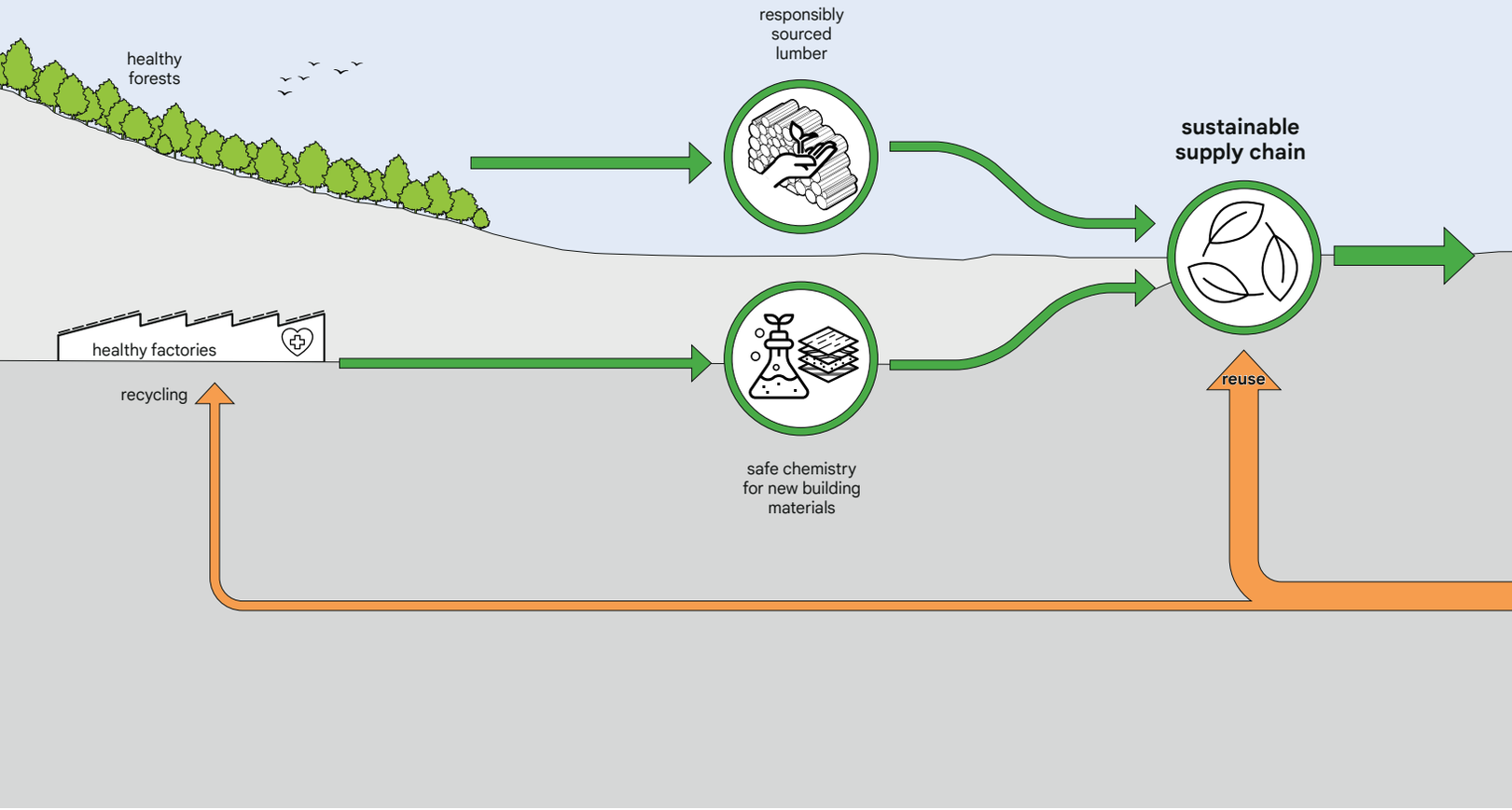
Left: A photo of Charleston East by Iwan Baan shows the thoughtful integration into its natural surroundings.

Charleston East Details

- On track to achieve LEED-NC v4 Platinum certification.
- On track to be one of the largest facilities ever to attain the International Living Future Institute (ILFI) Living Building Challenge (LBC) Materials Petal Certification.
- Dragonscale solar roof generates approximately 40% of the building's annual energy use.
- All building materials (numbering in the thousands) were reviewed to minimize Red List ingredients, common chemicals that are harmful to human and environmental health.
- 100% of lumber used to construct the building (both permanent and temporary) is certified by the Forest Stewardship Council (FSC), ensuring it comes from responsibly managed forests.
- Uses only non-potable water for toilet flushing, irrigation, and cooling, which reduces potable water usage by 40%.

- Aims to divert 90% of construction waste from landfill.
- Four basement-level cisterns totalling 720,000 gallons capture rain and stormwater for reuse in the building's non-potable activities including irrigation, toilet flushing, and cooling.
- 20% of the site is dedicated to promoting urban agriculture through native pollinator habitat, demonstration garden beds, and bee boxes.
- Establishes 383 native trees (two times the heritage tree replacement rate).
- Encourages sustainable commuting with 780-plus bike parking spaces.
- New bicycle and pedestrian paths along frontage roads create more open space for the community.
- Large outdoor public plaza with public art, plenty of public seating, and areas for farmers markets, food trucks, live music, and more.

Above: A view of Charleston East's interior canopy with clerestory windows bringing in abundant daylight.

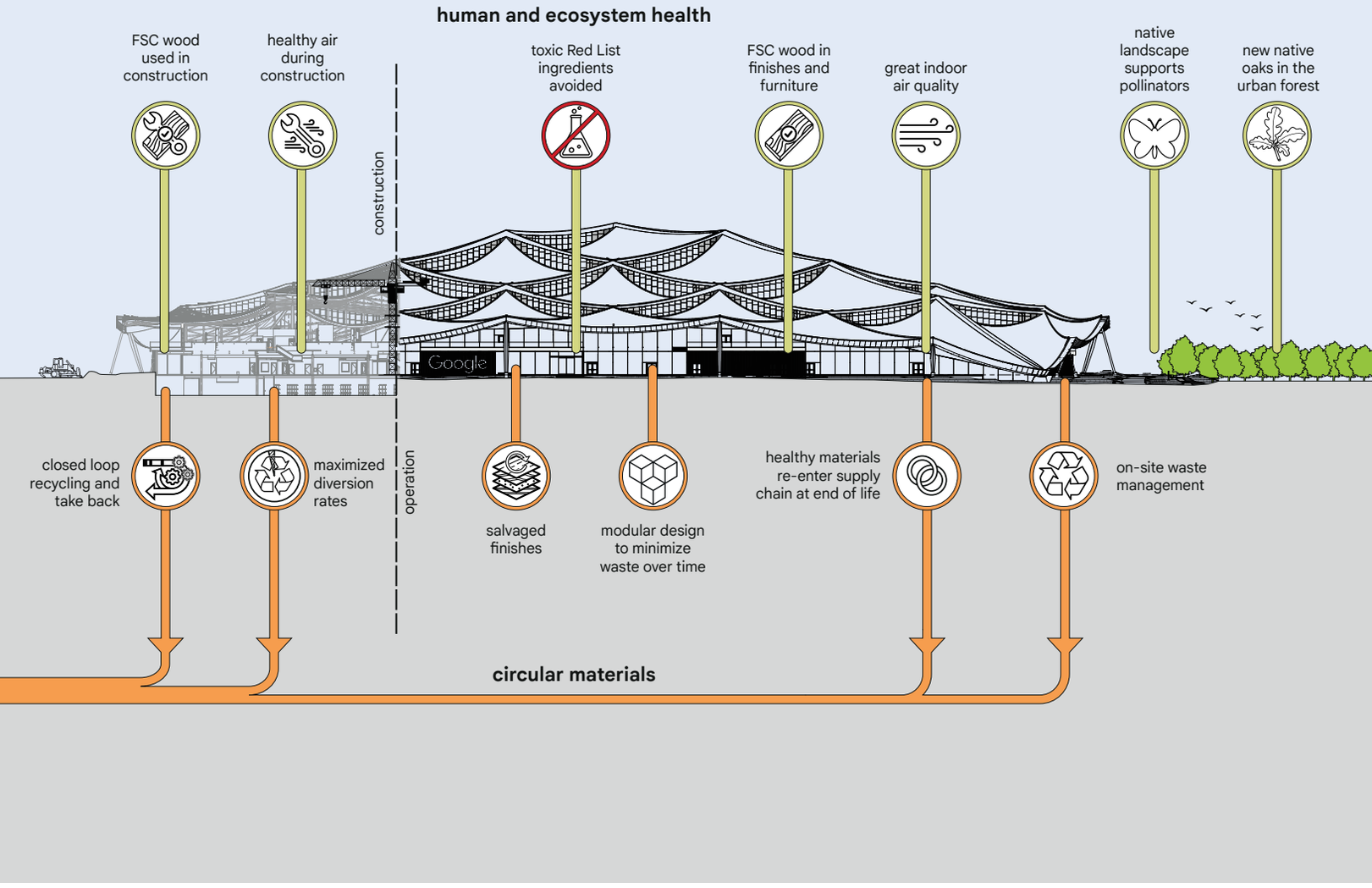


Integrated systems

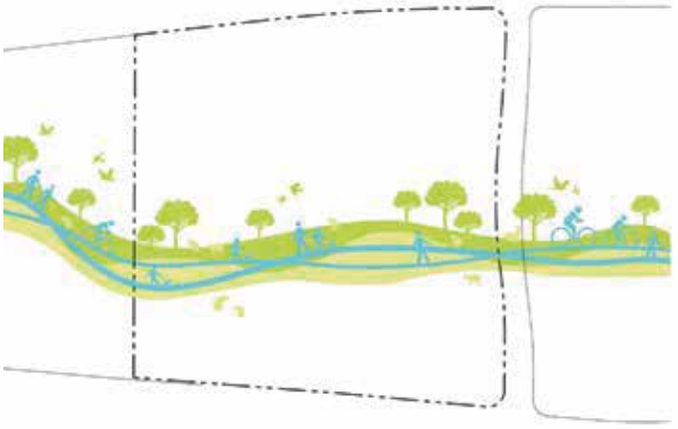
At Charleston East, we integrated the building into ecological and community systems in ways that are regenerative for both people and the environment. Emphasizing healthy materials – it's slated to be one of the largest buildings in the world to achieve LBC's Healthy Materials Petal – contributing to human and environmental health at every stage of the building's life.

To promote a circular economy, the design incorporates elements like salvaged materials and 100% FSC-certified timber. An on-site construction waste management process diverted over 90% of construction waste from landfills, and a closed-loop wallboard initiative meant we recycled over 530,000 pounds of drywall waste.

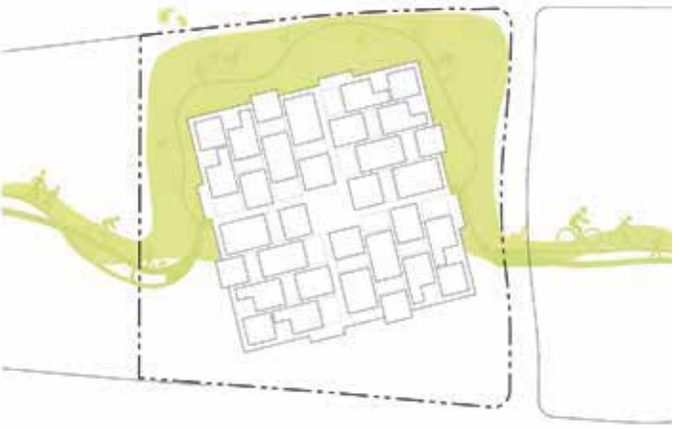
The circular design goals also help the building give back to its environment and community over its life span. The site design and native landscaping helps reestablish historical ecosystem elements that provide critical support for wildlife and build resilience in the landscape.



Above: A diagram by Ed Garrod from Integral Group and conceptualized by Kelly Stone showcases the concept of an integrated system that's regenerative for both people and the environment.



1. STARTING WITH THE GREEN LOOP



2. THE LOW PLANTING LOOP

3. THE CANOPY LOOP

4. THE PATH NETWORK

Green Loop

A pedestrian and bicycle path, part of the larger North Bayshore Green Loop, weaves around the southern portion of the 18-acre Charleston East site. Googlers, neighbors, and visitors can enjoy the site's native landscaping, urban agriculture garden beds, public art, and exterior public gathering spaces. The Green Loop connects to Charleston Park to the west, where a large outdoor public plaza sits between the building's west entrance and the park, which will be programmed with public events throughout the year.

The Charleston East Green Loop also connects to the first phase of the Charleston Transit Corridor, which will increase bike and pedestrian safety and make it easier to traverse North Bayshore without a car. Two transit centers constructed on Charleston Road adjacent to the building, along with planned bus-only lanes on adjacent streets, will help enhance regional transit options.

Above: A diagram studies different aspects of the Green Loop's connections to Charleston East.

Ecology

Charleston East's ecological design regenerates local biodiversity, while also contributing to biophilic interior and exterior spaces. Across the 18-acre site, four acres of which are vegetated, landscape designs mimic natural habitat native to the region yet largely gone from Silicon Valley today. A bioretention area on-site captures and filters stormwater and urban runoff, and the landscape palette consists primarily of native species, including 380 native trees. Over 90% of the plants provide nectar for native pollinators.

An ambitious re-oaking campaign resulted in an interconnected tree canopy including 142 native oaks, along with other tree species including madrone, sycamore, and willow. In the next decade, we estimate the oak network at Charleston East will provide 80,000 square feet of connected tree canopy.

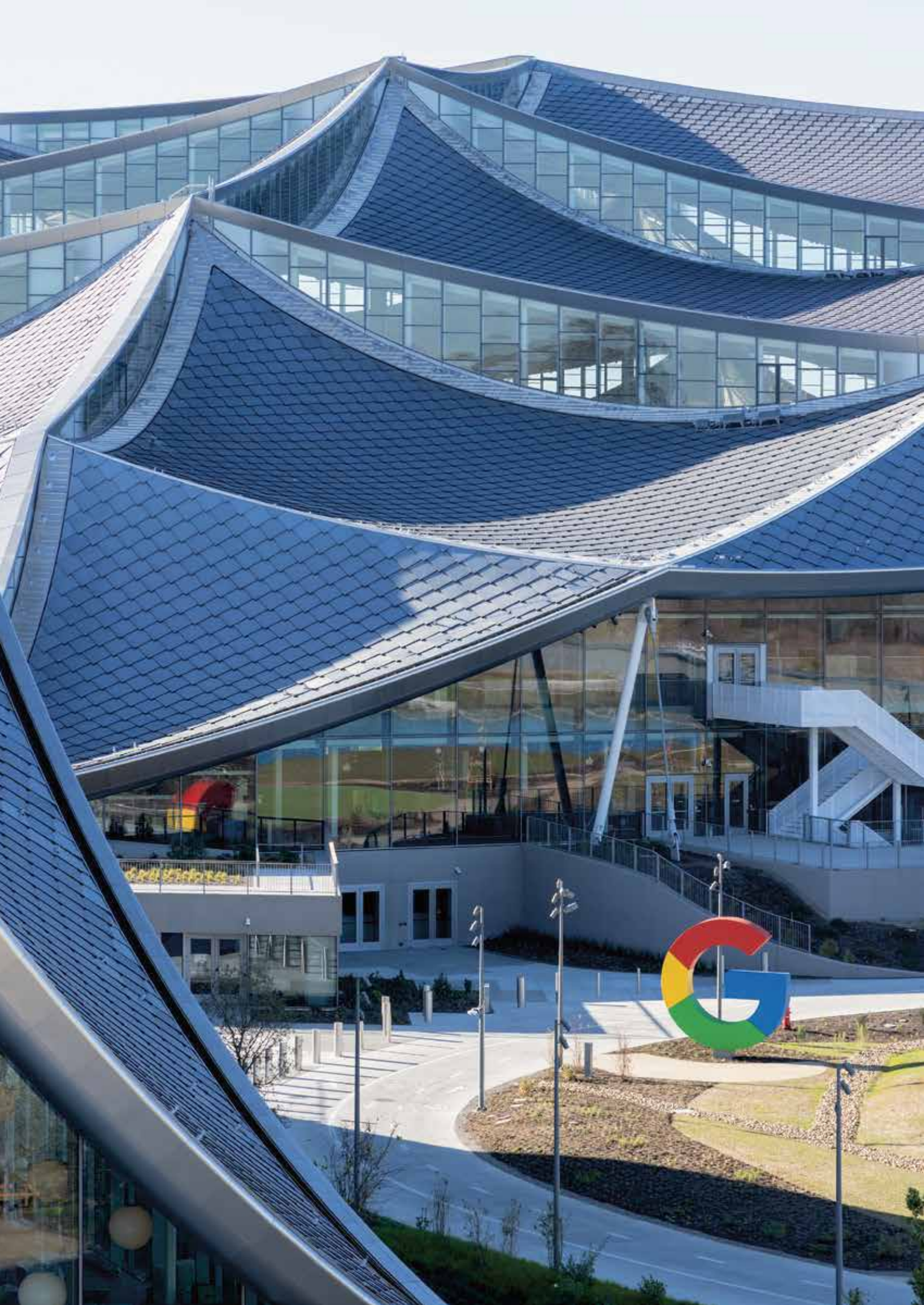
Above: In all of its projects, Google considers ecology with a focus on local biodiversity.

SOLUTIONS

To help solve big challenges in building for people and the planet, we know we can go further when we work together and think differently. We tapped the combined experience and creative thinking of thousands of Googlers and partners to design Bay View and Charleston East, and it's why we hope these buildings can serve as a case study for others. What follows are some solutions developed for these buildings, which we humbly offer as potential blueprints for future, as-yet-unseen innovations in sustainable, human-centric design.

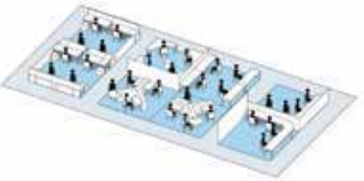
Together, the solutions reveal our fundamental interests in three central themes: Innovation, Nature, and Community. From the very first project charters drafted for Bay View and Charleston East, these three concepts have been at the heart of our goals, which were to provide Googlers a highly functional and flexible space that will adapt to future needs and reflect our key values. These are the ingredients we use as we pursue regenerative, inclusive spaces and places.

Innovation, Nature, and Community are by no means exclusive categories. In fact, in many cases, topics and ideas we explored at Bay View and Charleston East belong equally to multiple themes. For example, our approach to water considers natural ecosystems in the region, and requires novel innovations to generate a collective benefit to our communities and neighborhoods. We believe that no individual category should define a place; rather, a healthy balance of all three is needed to create environments where architecture, the natural environment, and people can coexist in harmony for generations to come.

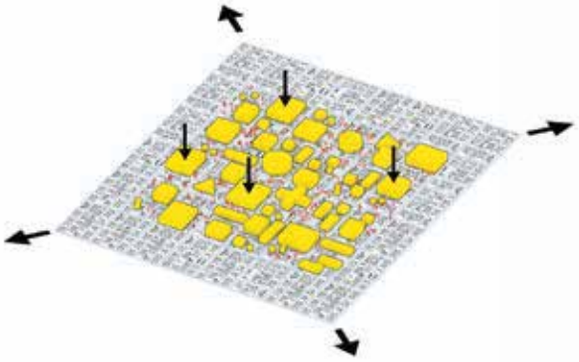


DESK

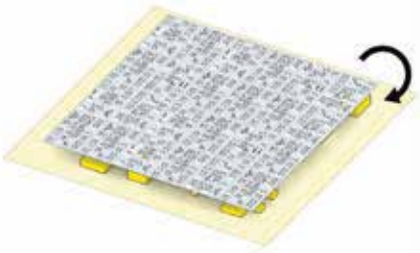
STUDIO



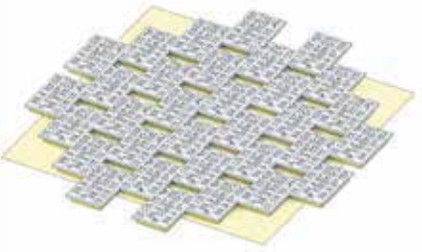
TEAM



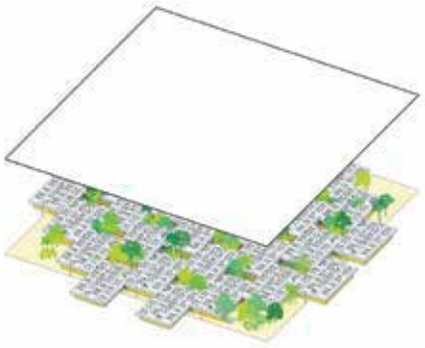
OFFICE SUPPORT



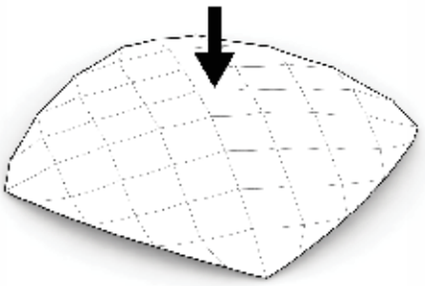
“UNDER THE RUG”



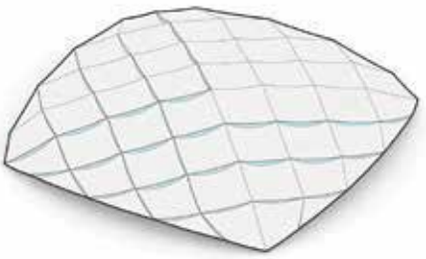
COURTYARDS



CANOPY



DRAPE



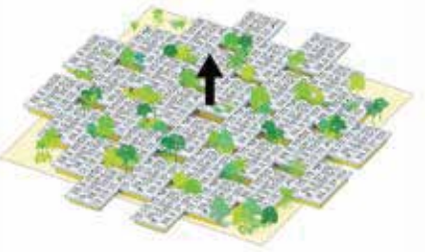
NATURAL LIGHT
& SOLAR POWER

NEIGHBORHOOD

COMMUNITY

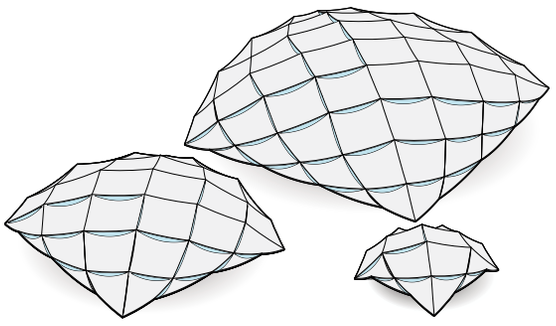
CITY

LOUNGES



STEPPED SLABS

COLUMNS



MULTIPLY!

Above: A series of diagrams studies the concept of designing "from the desk out," from the structural system all the way to the application of energy-producing photovoltaics.

Previous page: A view of the visitor entrance to Bay View, which is oriented towards the cycling and pedestrian trail.

Innovation

How can we make extraordinary environments within highly sustainable, scalable structures? It was this seemingly simple question that initiated our journey to design a new addition to Google's Silicon Valley campus at Bay View and Charleston East. Our design vision was framed by an audacious, moonshot commitment to crafting innovative answers to the central questions of how to assemble buildings within a landscape and organize the spaces inside. To us, innovative solutions are those that continually improve through use and over time. Our goal was to unflinchingly pursue innovations in building and environmental technologies on this project – not just for the benefit of Googlers inside, but for the wider industry, and for generations to come.

Looking up towards the underbelly of the canopies with light breaking through the clerestory windows.

An early rendering showing the concept for a structural ring beam that supported the canopy while providing a circulation loop for bikes and pedestrians throughout the building.

Design for Well-Being

Together, Bay View and Charleston East represent an experiment in enabling the future of work at Google and beyond. The design of both projects began with a deep dive into what powers Google: our people. Based on survey data and research, we know that Googlers are happiest and at their most productive and creative when they come together in teams. But we also know that deep-focus work requires individuals to be buffered from the very things that define teamwork: sound and movement. Solving this workplace conundrum was a key challenge in the design for these buildings. We sought to create a new type of workspace – one that supports deep-focus work, but also empowers collaboration, co-creation, and the best of being together.

At the same time, we continued our decades-long commitment to crafting the healthiest human-centric environments possible. We designed for well-being through every stage of the process – from construction to finished spaces, inside and out – to ensure our buildings have a positive impact on everyone they touch. This means we paid careful attention to the characteristics of spaces you can see and feel, like materials and daylight, but also to aspects that are harder to see, like air quality, thermal comfort, and acoustics.

Years of research and investigation into the physical makeup of Google's spaces informed our approach at Bay View and Charleston East. Today we know more than ever that human health and wellness, both physically and psychologically, depend on several factors: biophilic design; natural lighting; thermal, visual, and acoustical comfort; air quality; and promoting physical activity. Many of the design strategies for well-being that we've implemented here are not new to the world, but with this project we've taken them to an entirely new scale to prove what's possible. It's our blueprint for a future of human-centered spaces and places.

Teams-First Approach

"Ultimately, we started with the Googler," explains David Radcliffe, head of real estate at Google since 2006. "We investigated a few key things: why they come to the office, what they need from the office, what they need from their teammates, and what they need from the company. And we built out from there."

UX research from our real estate and workplace services group showed that our staff are happiest and most productive when they work in four- to eight-person teams, but also when they can retreat for individual focus work while still retaining easy access to their larger working organization. It's about having the best of both worlds. "We realized that what people really need is their teams, and what teams really need are communities," says Radcliffe.

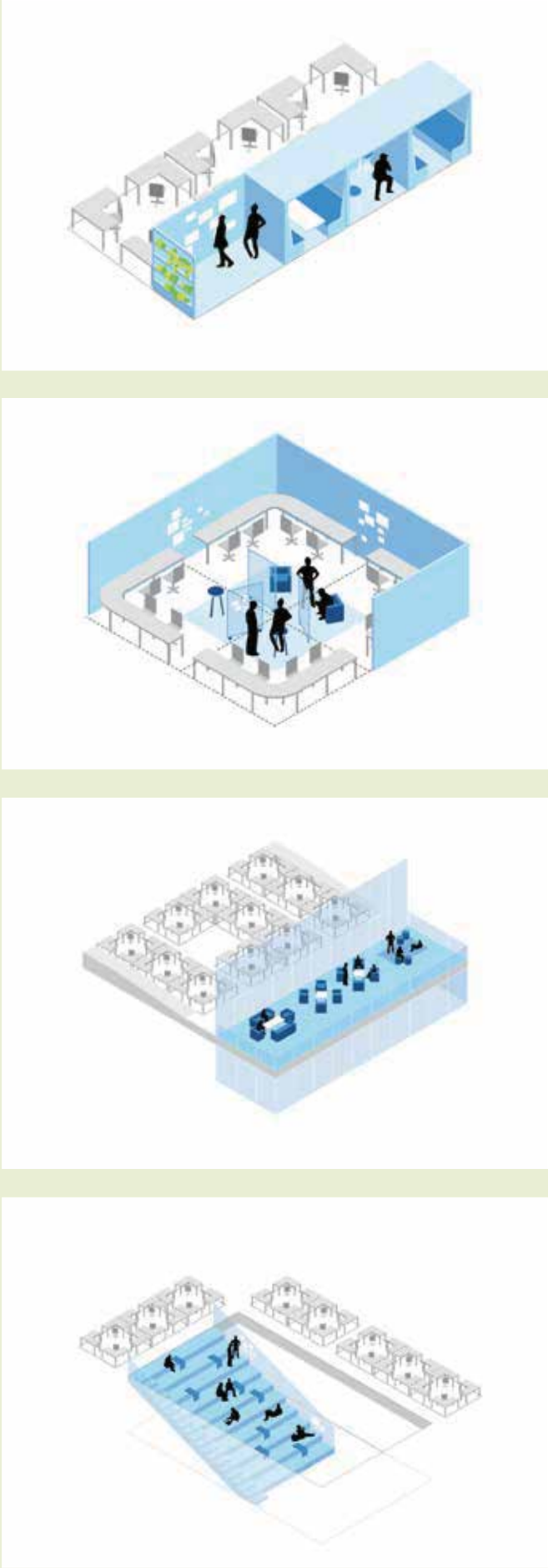
Through surveys, site observation, and one-on-one interviews with Googlers, we gathered tons of data about how teams work, what causes distraction, and the key factors for successful collaboration. Ultimately, we realized that as our teams grow, there are many benefits to keeping them under one roof. "With the design of Bay View and Charleston East, our goal was to have our larger teams of 2,500-plus people feel like they're in a connected space, but also balance that with the intimate scale of the four- to eight-person team," says Michelle Kaufmann, Google's director of R+D for the built environment, who led early user-group research that informed the projects.

That's how the idea for large-span buildings emerged – spaces where we could organize people all under one roof, and on one plane. We investigated solutions for longspan, lightweight, efficient structures that could maximize connectivity and flexibility inside. Rather than splitting people into different quadrants of a building or individual offices, we set out to rethink the open-plan office to better apply our years of teams-based research. As Thomas Heatherwick, who led the design alongside Bjarke Ingels, puts it, "We asked, do we really want to make offices that fix and calcify an organization? Or could we make something more flexible?"

At Bay View and Charleston East, we took a radically new approach to workplace organization, splitting the various 400,000- to 600,000-square-foot buildings across only two floors, with desks and team spaces on the upper level and amenity spaces below. By focusing the high-traffic areas and amenities in the lower levels, we remove many of the distractions that public areas can cause for those Googlers doing heads-down work. A series of indoor "courtyards" throughout the buildings connects the two levels, giving teams easy access to cafes, kitchenettes, conference rooms, and all-hands spaces below. The courtyards also encourage the physiological benefits of physical movement when circulating between levels and different modes of work, and double as wayfinding devices.

Above, the large-span canopy with average orthogonal column spans of 123 feet means the entire 200,000- to 300,000-square-foot second-level workspaces are open and connected under one roof. These work-spaces prioritize access to natural light and views, with reduced glare through carefully designed clerestory windows punctuating the canopy. Rather than being segmented by excessive columns and support walls, the structural innovation of the canopy roof allows for a wide-open workspace; every person has equal access to views across the floorplate, and through the perim-eter facade and clerestory windows to the outdoors.

"Normally, you would see a variety of program elements and amenity spaces mixed together with desk spaces,"



A diagram series studying ways to create team spaces intermingled with focus desk space to encourage collaboration and social interaction.

explains Chris Alwan, Google's director of corporate real estate development, who led the delivery of Charleston East. "Here we were able to separate the two. It's a remarkably simple solution." At the same time, the stepped floorplates on the upper levels establish a subtle rolling topography with a series of gentle "plateaus" or "tables" connected via wide ramps that elevate by 30 inches as one moves toward the center of the buildings. This gives a sense of scale to the vast space, and offers a 6-foot elevated vantage point to desks located in the deepest part of the buildings. The "tables" help compartmentalize team space while still giving everyone access to the entire floorplate, regardless of physical ability, and the strategy contributes to acoustic comfort and a biophilic variety of indoor experiences. It was important to distinguish these smaller-scale areas supportive of heads-down work, but keep everything connected on a very large floorplate so one can simply walk over, tap someone on the shoulder, and get their problem solved. The quality of space and volume under the canopy helps the second level remain at a human scale, despite the massive, open square footage. "It was always about designing these buildings from the inside out, prioritizing the human experience," says Radcliffe.

Indoor Environmental Quality

For decades, we've been slightly obsessed with indoor environmental quality (IEQ) in our workspaces. From stories of Google's founders walking around our early buildings, measuring indoor air quality with handheld particle counters, to vetting thousands of products to ensure we weren't introducing unnecessary toxics to our retrofitted interiors, we have long considered IEQ to be a key definer of healthy workplaces. "For Bay View and Charleston East, it was important to look at these spaces not just through an aesthetic lens, but from an environmental quality lens," explains Kate Turpin, Google's director of design performance.

Many of the IEQ standards we employed at Bay View and Charleston East didn't come from external ratings systems or recommendations, but from our own internal research. Mary Davidge, Google's former director of global design, explains that when we started thinking about IEQ nearly two decades ago, we had to define our own terms. "At the time, there weren't indoor air quality guidelines we could pull off the shelf and reference," she says. "We had to create those guidelines for ourselves."

In addition to a high level of particle filtration in the buildings, we used carbon filters to remove gas phase contaminants like ozone and volatile organic compounds (VOCs). We also provide ventilation rates far beyond industry standard since there are linkages between higher outside air rates and improved cognitive performance. We took this a step further at Bay

An early rendering shows a strong focus on making improvements to cycling and pedestrian pathways with spaces for the community to enjoy.

View by eliminating entirely the need to recirculate air. In traditional buildings, thermal comfort is regulated by introducing colder air into a space at a high velocity from overhead, inducing a mixing of air in the space to achieve a fairly consistent temperature throughout the whole volume. It's a standard but not very efficient method. Here, in the large-volume second level, we used an underfloor air system. This brings in cool, tempered fresh air at lower velocity, enabling us to cool just the portion of the space people occupy, and allowing warmer used air to rise toward the ceiling where it is exhausted from the top of the canopy. This approach means that the fresh air for ventilation also goes right to where people breathe, rather than mixing within the whole volume of the space.

At Bay View, we also used an overhead displacement ventilation system on the first level, using a similar lower velocity air distribution. Both projects incorporate a raised access floor on the workplace level, which means facilities teams can easily relocate the underfloor vents and electrical floor boxes as desk arrangements shift and change over time. What's more, the Bay View system uses 100% outside air – a remarkable achievement when you consider that typical HVAC systems reduce outside air down to 20-30% to conserve energy when outside air is significantly warmer or colder than what is needed to condition the interior spaces.

Biophilia

We know the quality of our indoor environments is defined not just by features like thermal comfort and superior air quality, but also by having access to nature and the rich, variable experiences found there. The best designs reflect the deep affinity between nature and human health, which is why we've included biophilic design principles in our workplace IEQ standards for many years.

"Biophilic design is essentially a belief that the built environment is a habitat for people," explains Kate Turpin, director of design performance. "At Bay View and Charleston East, we were trying to create a habitat where people will thrive." Research increasingly shows that regular access to nature improves our health, wellness, happiness, and performance. For these projects, it was important to have a variety of spaces that provide multisensory stimulation. In nature, it's common to be faced with encounters that run the gamut from serene and calming to awe-inspiring and stimulating. "We thought a lot about people's many different pathways through the buildings and how they might use different spaces throughout the day," explains Turpin. Certain areas in the building provide distant views across floorplates or down and across levels to mimic the natural feeling of prospect, while more intimate spaces offer a sense of refuge and protection. The goal was a design that would

"The design of the roof canopy was a fascinating problem to solve. We had to balance daylight penetration with aesthetics, glare, structure, fire protection, rainwater drainage, energy use, energy generation, and maintenance. We realized early on that the height and slope of the canopy created intimate dependencies between these considerations, so we had to collaboratively solve for all of them in an iterative fashion.

One of the most innovative parts of the project is the way the sun is allowed to penetrate into the internal courtyards. This was a core design element from the start, although no one knew how to implement it. After looking at next-generation materials and automation routines, we ended up creating a bespoke algorithm that anticipates when the sun will fall into each of the 26 courtyards. Roller shades retract in anticipation of this 'Indiana Jones' event without allowing sun to strike the surrounding workstations."

—Brendon Levitt, Loisos + Ubbelohde, Lighting and Daylighting Consultant

An early rendering shows the interior concept with a strong focus on biophilic design.

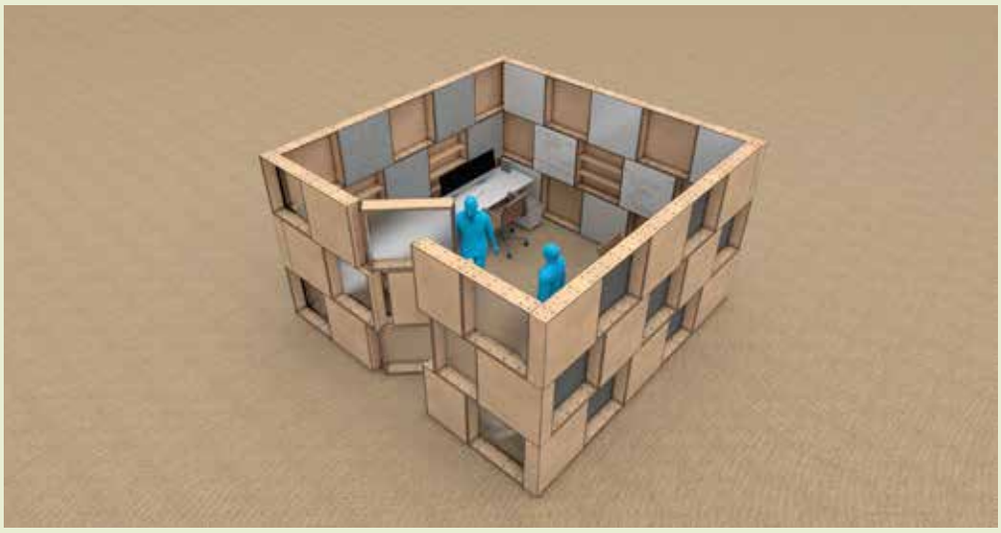
stimulate a variety of physiological, psychological, and emotional responses – much like being in nature. We also incorporated dynamic light and daylight, other key elements of biophilic design. We know that access to daylight supports healthy circadian system functioning, and that having varying intensities of light and shadow over time, in a manner that mimics nature, provides optimal human conditions inside. Placing the primary workspaces on the upper level of the buildings means everyone has access to natural light through the clerestory windows in the roof canopies. Beyond just democratizing daylight, these clerestories were carefully designed to keep direct light off of desks with window shades that open and close over the course of the day. "There was a great deal of technical rigor applied to determine when the shades should open and close to allow dappled light into the courtyard spaces, while also keeping desks free of glare and direct sun," says Turpin. Electric lighting throughout the building dynamically adapts to exterior lighting conditions, ensuring a comfortable indoor environment responsive to changing light levels from morning to night.

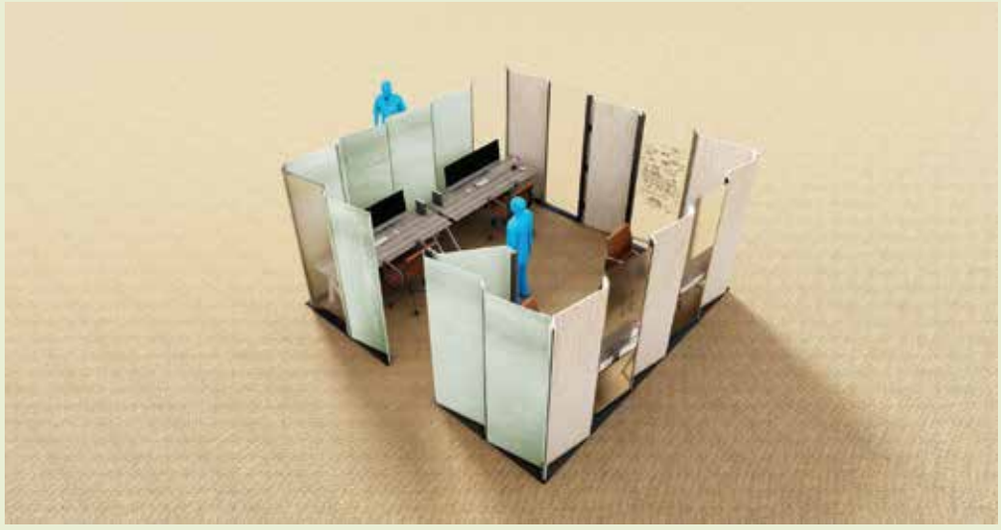
Visual and Acoustical Comfort

While the open office environment is great for collaboration and spontaneous interactions, visual and acoustic distractions can make it problematic for folks trying to do heads-down, focused work. We gathered extensive data over the years about how and when Googlers lose focus as a result of overhearing conversations or having activity enter their field of vision. Because the workspace at Bay View and Charleston East is concentrated on a single, open level, a big challenge was optimizing visual and acoustical comfort at the desk.

With ceiling heights ranging from 107 to 126 feet at Bay View and 32 to 113 feet at Charleston East under the longspan canopy, we knew acoustics would be tricky. "Our situation was even more unusual because we were putting literally thousands of people under one roof, all in an open environment," explains Turpin, who worked closely with acoustics consultants from Arup to tackle the issue. Our underfloor ventilation system is also extremely quiet by design, in contrast to typical overhead HVAC systems that provide a certain amount of white noise and speech privacy. Our solution was twofold, tackling the issue at micro and macro scales.

At the macro scale, we carefully calibrated the sound absorption in the canopy with an acoustical metal deck to help mediate acoustical comfort, but also to ensure the space didn't reverberate or sound tinny. At the micro scale, our R+D for the Built Environment team, led by Michelle Kaufmann, did a lot of testing on different materials and scales of partitions to





Three different designs for a team space with varying degrees of privacy and a flexible design that can easily change over time.

Bay View hosts the largest fitness center in Google's portfolio.

An illustration of the interiors at night studies how localized light can be applied to team neighborhoods.

maximize comfort at the desk and team levels, while also prioritizing economy and ease of adaptation. We knew the partitions had to remain open at the top for building code purposes, but beyond that, all options for materiality and scale were fair game. We explored a range of materials and configurations with Google user groups, and ultimately we discovered that 9-foot-tall partitions made from easy-to-reconfigure modules provided good sound mitigation. These, along with the rolling topography of slightly raised and lowered levels across the floorplate, help address visual distraction. At the desk level, we also included elements like flexible screens and sun visors so users have a final level of control and personalization, allowing them to customize their space for focus and comfort.

Googley Interiors

Beyond healthy interiors that are flexible in perpetuity, workspaces at Bay View and Charleston East also needed to reflect our identity and ethos. In short, they needed to feel Googley. "Over the course of designing Bay View and Charleston East, we developed six aesthetic attributes for all of our workplace projects, which are also applied here," explains Josh Bridie, director of global interior design at Google. Those six attributes are: Natural, Residential, Localized, Culture, Workshop, and Effortless.

"Natural" refers to the elements of biophilia we've introduced to the spaces, both from a materiality and an experiential standpoint. "Residential" means that instead of a monolithic design statement, we wanted something varied and visually textured. "We wanted the interiors to feel warm, welcoming, and collected over time, so as to appeal to the human spirit," says Bridie. "Localized" means the design of the spaces is truly grounded in the community where they're located. At Bay View, that happens through the application of five biomes that serve as interior inspiration for various sections of the building. The biomes mimic those that naturally exist on the peninsula between the San Francisco Bay and the Pacific Ocean, including tidal/marsh, grasslands, scrubs, dunes, and oak/savanna. These biomes also informed the site-specific art created for Bay View – more on that later.

The final attributes have to do with our affection for rough-and-ready maker spaces where nothing is treated too preciously. "Workshop" refers to the sense that Googlers like to tinker, so we wanted to make sure the building didn't feel overly prescribed. "Folks can take control of their environment and personalize it, rather than feeling like the spaces must remain in their pristine form," says Bridie. "Culture" is about ensuring there's an expression of Google in the spaces that's relatable, and also reminds people they're part of a broader global culture. The last attribute, "Effortless," relates to our belief that often the most beautiful designs come from a simple, clean approach where things are left in their pure, unadulterated forms. Ultimately, we wanted the spaces to feel natural and intuitive, so the building seamlessly reveals itself to people as they go throughout their day.

"Often referred to as 'a city within a building,' Bay View's interiors needed to serve and organize thousands, while still offering an impactful experience for the individual. The teams worked at an enormous range of scales to develop an interior environment that offers both cohesion and variety; space-making and place-making; assembly and refuge; and collaboration and focus.

This project goes well beyond baselines we often see in our field for environmental quality and impact, and pursues incredibly high standards for spatial equity, healthy design, and sustainability. For example, the interiors are broken down into discernable neighborhoods with clear identities that are relatable at a human scale. Simultaneously, strategies of texture and color, graphic and material wayfinding, programmatic resource localization, acoustic mapping, lighting design, and art landmarks were used to create one holistic composition for user exploration. Our hope is that the building successfully strikes a balance between intuitive logic, and surprise and delight.

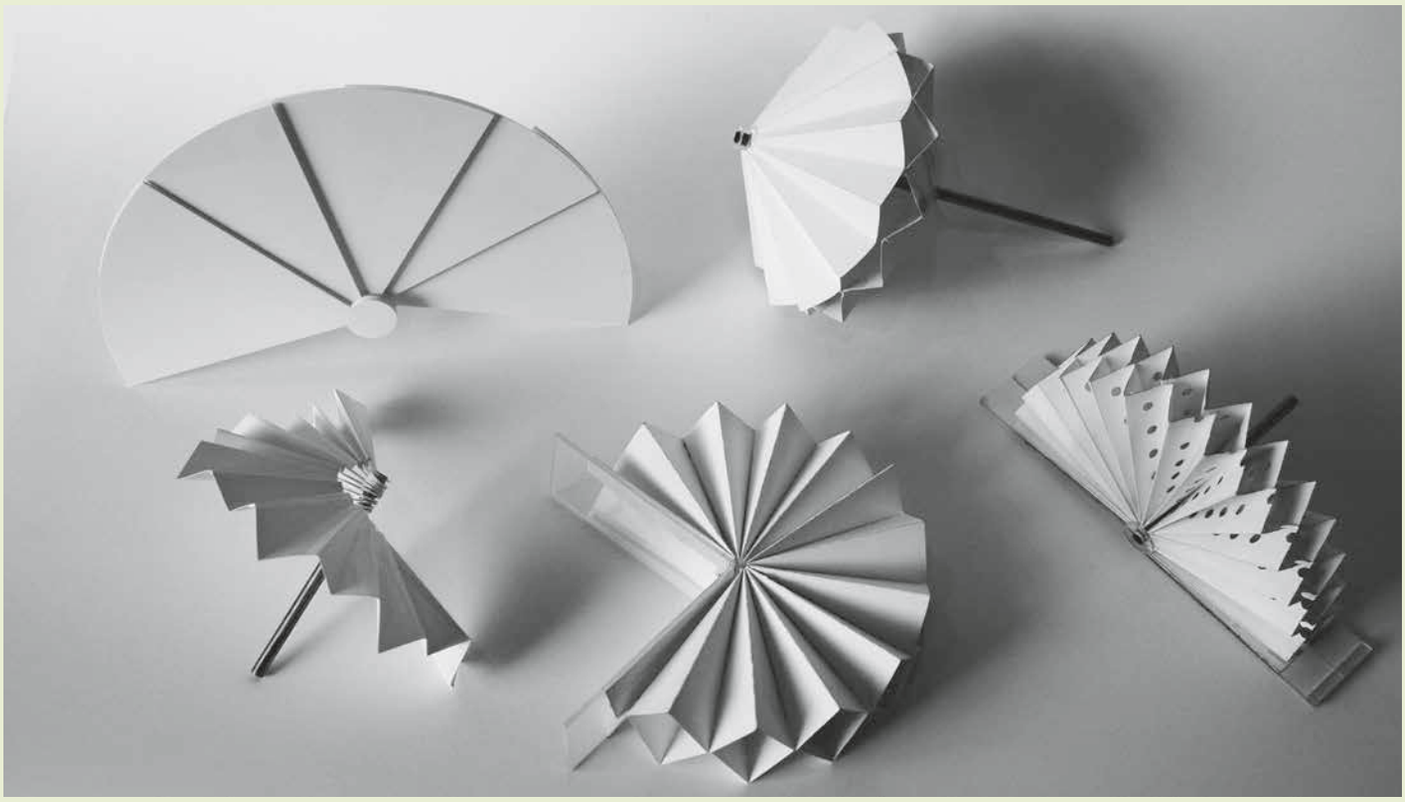
This project reminds us that the workplace has become a much more precious commodity since the pandemic began. It is a space for togetherness, for collaboration and interaction; and it also functions as an important equalizer for spatial equity."

—Thomas Yee, STUDIOS Architecture, Interior Architect of Record

A rendering looks at the importance of courtyards as gathering places below with access to focus areas above.


Magnolia

An interior photo of Bay View shot by Iwan Baan.



Deployable shading structure mock-ups from the Google R+D Lab for the Built Environment. Many shading techniques and technologies were built and studied in-house early on.

Design for Flexibility

There's only one thing we know for certain about the future of work: Technology is advancing at such a rapid clip, it's impossible to know what work will look like twenty, ten, or even five years from now. That's why our goal from day one was to design the most flexible work environment possible that enables equitable experiences for all. "We thought about the volumes of the buildings as similar to the mass of a theater, where a great open span allows for people, props, and stages to be moved around inside," explains David Radcliffe, Google's head of real estate. Above all else, we knew the interiors of these workplaces needed to be able to flex and adapt to meet the changing needs of Googlers and the ever-evolving nature of work.

Early on, this design driver led to the idea of the canopy. "The canopy is a minimal way of creating a conditioned environment," explains co-lead design architect Bjarke Ingels. "Under that canopy, we could create a village of different ways to accommodate all different types of workspaces."

At Bay View, which sits adjacent to the NASA Ames Research Center, we were inspired by nearby Moffett Airfield and its three large 1930s-era airship hangars. "Seeing these vast, engineering-led spaces was a breakthrough for us," says co-lead design architect Thomas Heatherwick of the longspan, arched structures. "It was when we realized that we could make something flexible, in the same way that a hangar creates protection for everyone inside, but is also unlimiting."

We explored and tested several ways of executing the canopy superstructure. Led by Michelle Kaufmann, Google's director of R+D for the built environment, we considered options like an all-glass canopy with integrated PV and automated shading systems; large-scale space frames; and even a fully inflatable pneumatic structure. Because it was imperative that the canopy system be as energy-efficient as it was economical, we landed on a net system made of tubular steel (we call it a "tube net") with simple clerestory windows between the canopy bays.

Selecting an opaque roof structure (rather than glass or some other translucent material) gave us the best acoustic control, minimized thermal heat gain, lowered overall energy loads, and allowed us to harvest the maximum amount of solar PV on the outside. It also provided excellent daylight inside without excessive glare, allowing every desk in the building to have views out and access to daylight through most of the day. In short, it was the best solution for doing more with less.

Innovative Canopy Structural System

We knew that spanning such long distances with a minimal amount of columns would require a highly innovative engineering approach, along with a committed construction strategy to ensure durability of the structure, as well as worker safety, during assembly. That's why we collaborated with structural engineers from Thornton Tomasetti and Arup, along with general contractors from Whiting-Turner and Hathaway Dinwiddie, to design a buildable solution. At Bay View, one of the canopies covers a footprint of nearly 500 by 500 feet at its widest spot – an area equal to nearly four and a half American football fields. "The canopy was immensely challenging, from a design perspective, a detail perspective, and a fabrication perspective," says Kavi Singh, the Google real estate development executive on Bay View. "The canopy would not have been possible without the critical problem-solving provided by the contractors who built it. It took a true collaboration from all involved to make it happen."

At Bay View and Charleston East, the canopies combine compressive structural typologies (think an arch or dome) with tensile net structures (think a sagging tent) to achieve longspan with less steel tonnage per square foot than traditional construction. This combination of different structural typologies is highly unusual, and it resulted in the buildings' sweeping, wave-like roof forms. It also helped us answer the sustainability ambitions of the project that prioritized lightweight, efficient structures, as it meant we reduced the overall material and weight of the canopies. "It's about addressing the footprint of our buildings," explains Radcliffe. "When you challenge yourself to build things that are lighter, you're using less resources and creating less waste."

This innovative structural system meant our engineers had to work closely with construction teams to come up with efficient and safe site-specific approaches for constructing the canopies at Bay View and Charleston East. The Bay View team spent two years designing and planning their approach, which involved three longspan canopy roof lifts. Prefabricated steel bays of roof framing were combined with longspan trusses to form the roof assembly, which was constructed on the ground before being hoisted up via strand jacks and set atop supportive columns. (A strand jack is a specially configured hydraulic jack that can lift extremely heavy

A structural model of the canopy showing the tensile bays and clerestory trusses spanning between a field of slender columns.

"All aspects of the exposed 'tube net' roof design, from the overall arrangement and density of the tube grid to each of the steel connection details, were developed in close collaboration with the architects for form and aesthetics, and with the fabricator and erector for ease of construction. While the eggshell-thick roof is structurally highly efficient, it is inherently more flexible than a more traditional trussed roof, so close coordination with the roofing and facade systems was required.

Erecting this relatively flexible structural form required an innovative approach, because the roof net does not achieve its overall stiffness until it's fully constructed. Consequently, if the roof were to be assembled in the air in pieces, there would be risks of exceeding erection tolerances and embedding residual catenary stresses in the structure. By conventional methods, significant shoring would be required for the overall height of the roof, some 160 feet above grade at its peak. The Bay View team, including our erection engineers working with Schuff Steel, developed an innovative erection sequence to assemble the roof on shoring just above the ground-level slab, before jacking the assembled panels into place.

The result provides a tremendous sense of space and volume. Exposed curved steel pipes in the roof surface, rhythmic simple details, tall and slender columns, and taut perimeter tie-down cables complement the original design intent of a light, tensile structure."

—Bruce Gibbons, Thornton Tomasetti, Structural Engineer

loads). The largest roof lift at Bay View consisted of 12 bays of preassembled roof framing connected by 32 trusses (totaling more than 180,000 square feet of roof structure) and required 42 individual strand jacks synchronized atop 21 support columns. The system set a record for the largest number of strand jacks used at one time to support and raise the roof assembly, which weighed in at more than 2,600 tons.

At Charleston East, the canopy structure is lower than at Bay View, with more densely spaced columns. Here the superstructure is underpinned by 53 columns, each supporting approximately 10,000 square feet of roof area. These structural nuances and the self-supporting roof design mean that the canopy and the human-scale structures are not connected, so at Charleston East we were able to explore the integration of cross-laminated timber (CLT) into the structural system for the human-scale elements. We used CLT as the formwork for the concrete floors, where it provides composite strength. We used wood certified by the Forest Stewardship Council (FSC) for this formwork, and integrated it in such a way that, rather than being removed and disposed of as is typical practice after the concrete sets, the CLT is left in place to offer structural support, while also doubling as exposed wood ceiling for the areas below.

Ultimately, we see the canopy system as the key element that will help these buildings stand the test of time. "The longspan structures contribute to a broader definition of sustainability," explains Sarah Gill, our district workplace design lead. "That definition is about how to design the most expensive parts of a building to last a long time, while also allowing for a large degree of flexibility inside. The superstructure can accommodate a lot of dramatic change over time – change we're not able to predict."

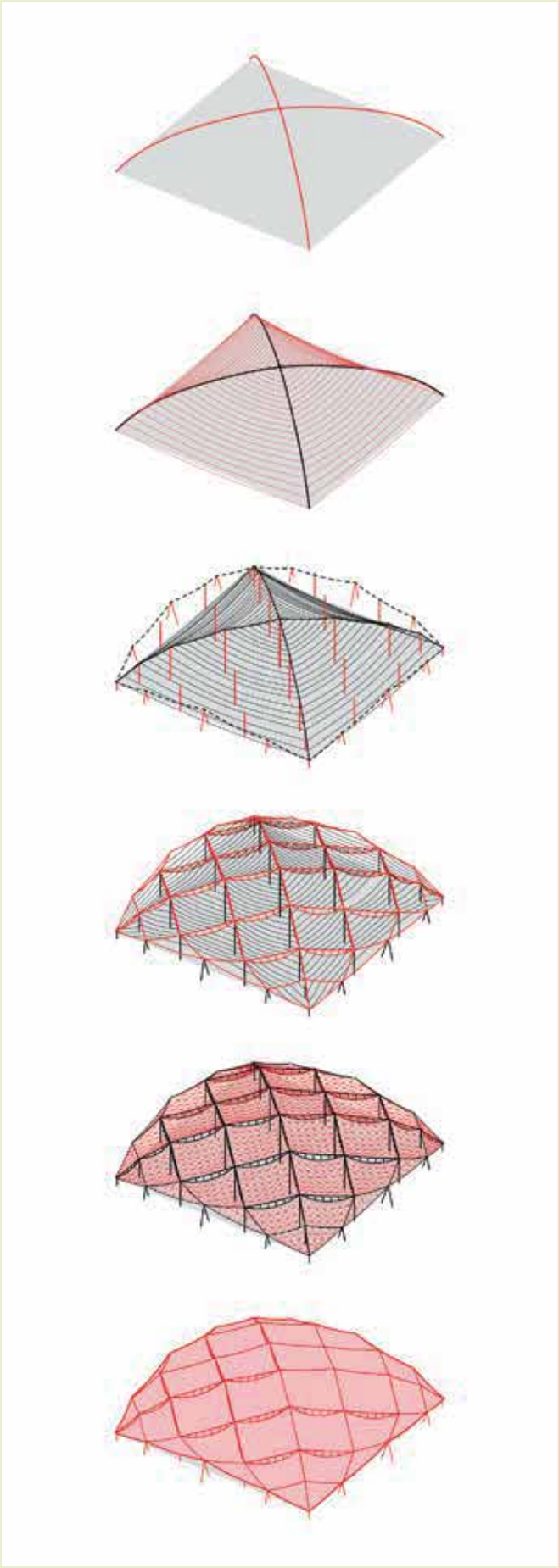
Seismic Resiliency

"On this project, we tried to push the envelope in terms of seismic resilience," says Parham Khoshkbari, Google's director of infrastructure. At Bay View and Charleston East, the structural systems were designed to high seismic standards. The canopy employs a non-traditional, seismic force-resisting system of trusses, columns, and diagonal braces. "Because these systems are not standardized in the building code, the engineers used performance-based design methods targeting the highest level in the code, which in this case is the Immediate Occupancy performance level," explains Khoshkbari. This means we used advanced analysis methods and independent review to target design goals around achieving a structure that will sustain little to no damage in an earthquake event, so the buildings are more likely to remain operational afterward. "This is the performance level stipulated in the code for buildings like hospitals, emergency operations centers, and power plants, not necessarily for office buildings," says Khoshkbari.

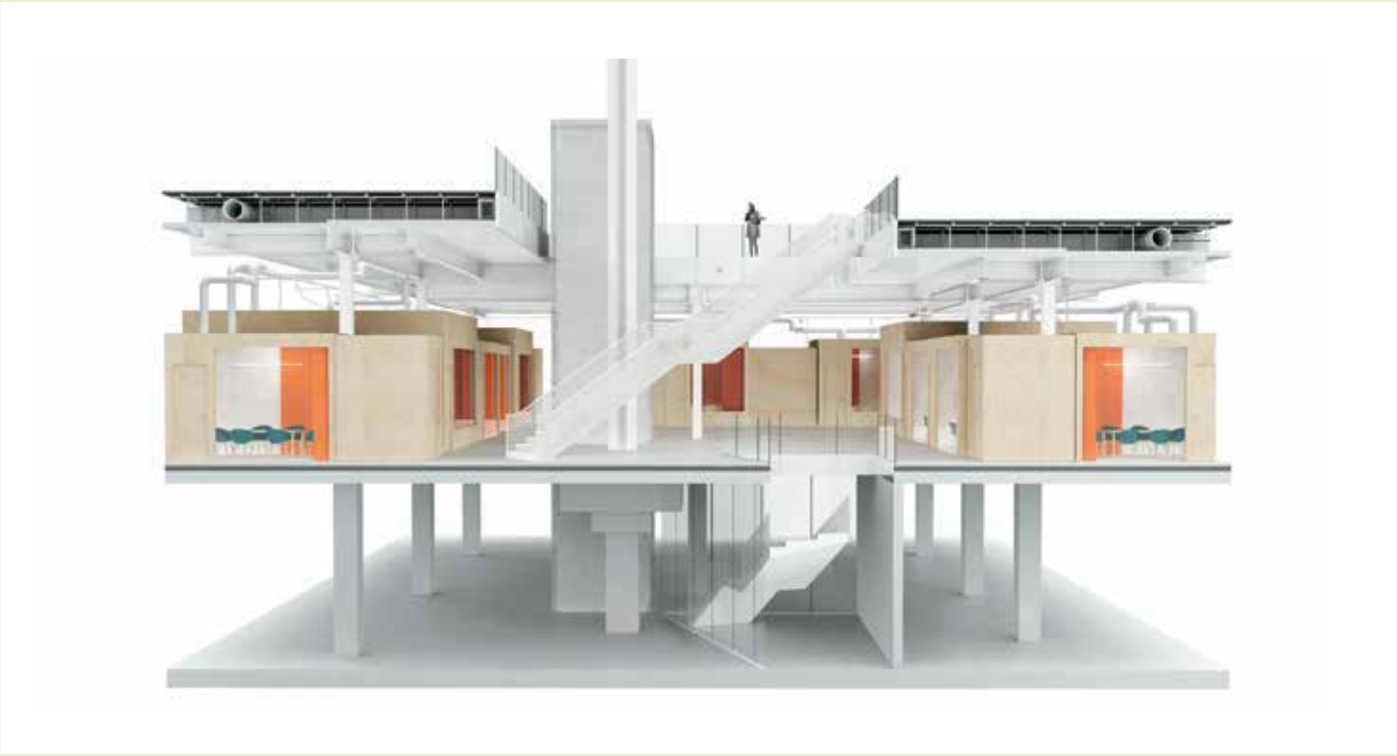
Adaptable, Human-Scale Spaces

We've put a lot of focus on designing flexible, modular, desk-first environments that can be adjusted quickly and efficiently based on team needs. At Charleston East and Bay View, we've parceled out the floorplates in such a way that each smaller team neighborhood has a designated area – their home base – while still being in the vicinity of their broader team. A typical team pod is for approximately eight people and a neighborhood is for teams of 40 people. As teams grow – which they always do – they'll be able to expand into adjacent areas.

At the same time, the buildings' infrastructure supports ultimate flexibility within each team pod, meaning we can easily move or reconstruct wall sections whenever needed. For instance, if a team has a project that requires a little more privacy, we can create a temporary space to accommodate that. Flexible partitions in a variety of materials provide privacy for individuals and collaboration space for teams, and can be quickly accommodated by the raised access floor, which ensures that fresh air still flows equitably and efficiently from below. Various mobile furniture and accessories, like white boards, storage, and large tables for collaboration, are all on casters and can be rearranged over time. "We thought about the ease of conversion in three different time scales: two minutes, two hours, and two days," explains Josh Bridie, global interior design team lead. Task lights, flexible screens, and custom-designed sun visors allow individuals to convert their desks in two minutes, while flexible wall systems mean teams can convert their parcels within two hours to suit a new task. Broader, facilities-based changes such as assembling and disassembling



A series shows the build-up of the canopy with a net system of tubular steel ("tube net") and clerestory windows between the canopy bays.



A sectional rendering of the Bay View human scale showing how the interior architecture, structure, and MEP systems integrate with one another.

As proof of concept, the designers made a 1:1 mock-up of the fluted concrete fascia to discuss buildability with the general contractor.

"One of the greatest challenges our team faced was achieving the architectural vision of the canopy in a seismically active region. Due to planning restrictions, the shape of Charleston East's roof is flatter than traditional domes, which are able to internally resolve lateral forces. While other buildings in seismic zones rely on braced frames or walls to counteract lateral forces, every steel roof component of Arup's structural design helps resist both gravity (vertical) and wind or seismic (lateral) forces.

Our team was inspired by the concept of catenary action (the basic parabolic profile of a suspension bridge cable) and expanded it to three dimensions. If you slice through the roof in any direction, the shape of a catenary tension cable is revealed. This structural approach also enabled clerestory skylights to introduce natural daylight across the upper-level workspace.

As the structural 'tube net' design details developed, it became clear that the multi-angle connection node details at the tops of the columns did not lend themselves to an I-beam column configuration. We selected a cruciform column solution, which provided the structural strength and stiffness requirements we needed in all directions, while at the same time creating vertical conduit and piping pathways in the corners of the cruciform to the top of the building. The result is a simple and elegantly executed roof for Charleston East."

—Atila Zekioglu, Arup, Structural, MEP, and Acoustic Engineers of Record

partition walls are achievable in a weekend's time. "We put a lot of work into ensuring these spaces can truly adapt to the unknown," says Bridie.

That also means being able to adapt to changing work styles, which is why the team pods are designed to seamlessly accommodate hybrid work experiences in a way that is equitable for everyone – whether they are physically in the office or connecting via video call. A key focus was making sure in-office days tap the best of what it means to be together, while simultaneously empowering virtual connection with colleagues in different locations and time zones.

"We embraced the idea of turning the office inside out," says Google and Alphabet CFO Ruth Porat, explaining how we flipped the typical relationship between focus and collaborative spaces and their association with open versus closed space. Besides shifting away from open desking toward more enclosed nooks for focused work, we have balanced enclosed meeting rooms with a wider range of open collaboration spaces. These areas are more accessible and adaptable based on team needs. "We're not getting rid of conference rooms altogether," says Radcliffe. "But there are many more places to collaborate in the open."

Many of these spaces are fitted with integrated A/V technology to ensure remote colleagues have equal participation and presence. By pushing the boundaries of flexible workspace design, we enable Googlers to toggle between collaboration and focus, on-site and remote work, as these needs arise.

A close-up of the dragonscale building integrated photovoltaic system that aims to make solar part of the architecture rather than an add-on.

Design for Energy

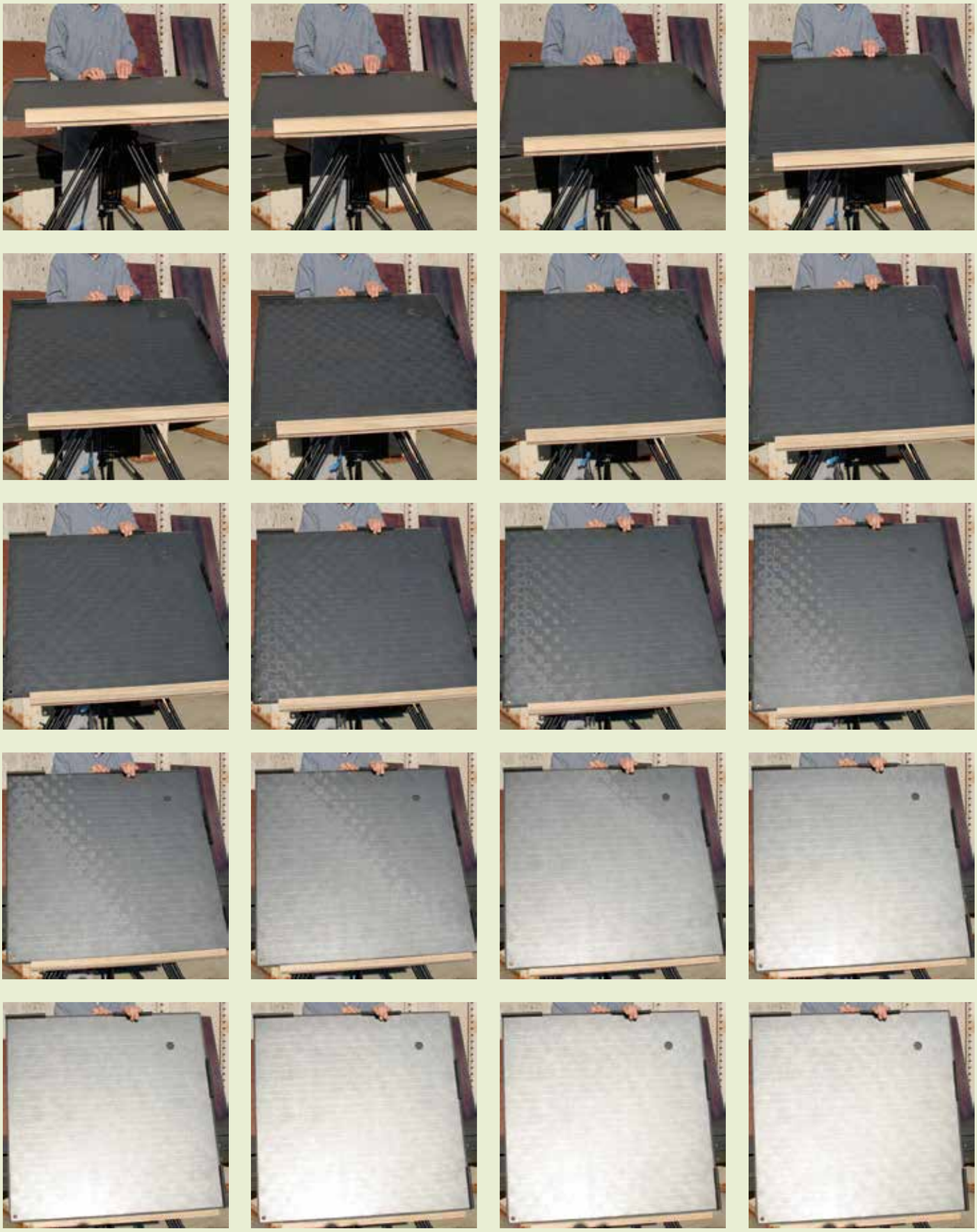
"Every element in these buildings is doing more than one thing," explains Asim Tahir, Google's director of energy and carbon. To us, designing for energy efficiency has to do with technologies and advanced building systems like integrated solar photovoltaics and geothermal, but it's also about taking a more holistic approach to making our buildings work harder. "Everything is integrated, nothing has a single job," says Tahir. "We looked at it from the desired outcome, which was to minimize waste in all forms."

To hit our companywide goal to operate every hour of every day on entirely carbon-free energy by 2030, it's important to prioritize alternate sources of energy, like solar, and maximize the amount of solar energy our buildings can capture. At the same time, we need to drive toward innovative ways of reducing the amount of energy we use in the first place. That's why we prioritized daylit workspaces and highly efficient HVAC systems. The geothermal piles at Bay View help heat the buildings in winter and cool them in the summer, which is estimated to reduce carbon emissions by almost 50%.

It's also why Bay View is a 100% all-electric campus where even the kitchens are electric to help decrease carbon emissions. Electrification is a key component of our carbon-free energy goal – we can't achieve this if we continue to burn natural gas in our kitchens. There are also health benefits to all-electric kitchens, as they improve indoor air quality and increase safety and comfort for our staff. At Bay View, we've outfitted the two kitchens serving seven cafes with all-electric equipment, and they – along with the rest of the campus – are powered by 90% carbon-free energy. It's a template for how to move toward fully carbon-free cafes and kitchens to dramatically reduce the burning of fossil fuels in our campuses, and beyond.

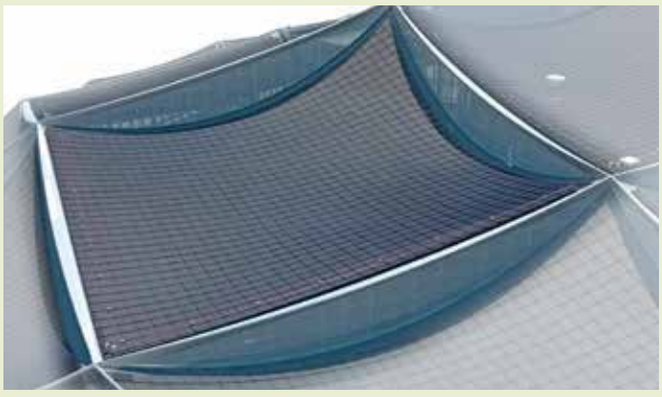
Dragonscale Solar

We knew from the beginning that Bay View and Charleston East would incorporate solar PV technologies to generate their own energy and reduce reliance on the municipal energy grid. When the building designs evolved into large canopy structures, we saw an opportunity to adapt solar panels to that unique shape in a way that could maximize the amount of energy captured – and look good while doing it. The buildings feature a first-of-its-kind dragonscale solar roof, equipped with a total of 90,000 silver solar panels across all four buildings. Combined, the solar roofs give Charleston East and Bay View 7 megawatts of installed renewable power – providing roughly 40% of their annual energy needs.



A sequence of images taken as part of efficiency, reflectivity, and color studies for the dragonscale shingles. The images show how the sun angle has a major influence on the perceptible color of the shingles.

The team reviewed various color grades of photovoltaic cells and specified a tight range of color for use in the dragonscale shingles.



A study looks at the performance, color, and quantity of dragonscale solar shingles needed for a bay.

Leon Rost (left) and Joshua Plourde of BIG with Google's Sarah Gill testing photovoltaic solutions at the Google R+D Lab for the Built Environment.

The dragonscale solar roof is the result of years of product development and R&D at Google; collaboration with a handful of partners; and examining prototypes from manufacturers the world over. Eventually, our partners at Switzerland-based SunStyle brought us a highly textured prismatic glass shingle with a unique coating technology. The prismatic nature of the glass traps light that would normally escape from traditional flat solar panels, and has the added benefit of reducing reflective glare that can be a problem for drivers and pilots. The texture also gives the panels a unique sparkle, which helped earn the name "dragonscale."

The solar shingles are arranged in an overlapping diamond configuration, which helps keep wind, rain, and ice from slipping through the cracks. Installing overlapping shingles on a curved roof was no easy feat, and we relied heavily on expert contractors, including electricians from Sprig Electric, REC Solar, and Blue Oak Energy to solve constructability questions as they arose. Coupled with the canopy's pavilion-like rooflines, the panels let us capture the power of the sun from multiple angles. Unlike a flat roof, which generates peak power at the same time every day, our dragonscale solar skin generates power during an extended amount of daylight hours. This will limit our contribution to California's notorious duck curve, which tracks the difference between energy demand and the available solar energy throughout the day.

Shortly after construction began, we couldn't help but think about how we might make this holistic approach to PV design more scalable. After all, we can't custom design and develop a new solar solution for every project. Integrating solar panels into a roof, like we did with dragonscale, is one approach to using building-integrated photovoltaics (BIPV), while another is incorporating them into the skin of the building. Either way, the challenge is to do it in a way that looks good. The constraints of traditional manufacturing processes also make BIPV projects more difficult. Currently, buildings featuring integrated solar panels require custom-designed and manufactured panels, which only niche producers using flexible manufacturing processes with limited output can produce. For our newer buildings, we have instead been incorporating a standard solar panel size (3 by 5 feet) with standard panel mounts into our designs. This will allow us to use more prevalent, high-volume manufacturing processes so that production and installation can ramp up quickly and at scale. "It's about solving the right problem at the right scale," explains Tahir. "Hopefully this project is just the beginning, and those ideas will continue percolating."

Integrated Geothermal Piles

To us, integrated design is about relentlessly pursuing building solutions that solve multiple problems at

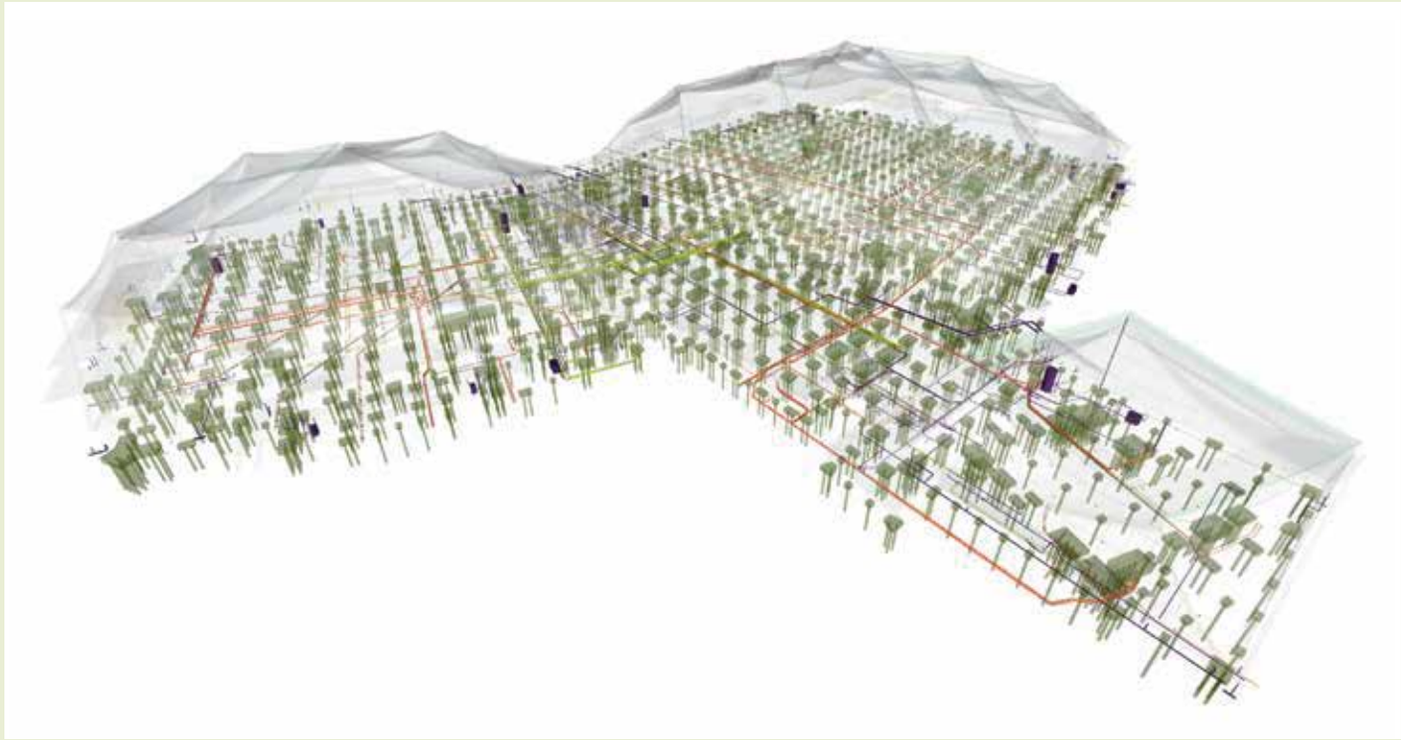
once. At Bay View and Charleston East, this happens inside and around the buildings, but also in the ground beneath them. For years, we've been experimenting with ways to leverage the earth's natural thermal mass to heat our buildings and their water supplies. We've carried out geo-energy feasibility studies for our districts, and piloted ground-source heat pumps and other natural heat recovery and thermal storage systems in our buildings, all part of our effort to move away from using fossil fuels to heat our buildings. At Bay View, we've taken our research a step further, selecting a versatile, drilled, cast-in-place foundation, which allows us to incorporate an energy recycling system that uses the geothermal properties of the soil to help heat and cool the buildings. The result: the largest geothermal pile system in North America, with pipes totaling nearly 100 miles in length and covering a surface area equal to 12 American football fields.

When selecting the foundation systems for both Bay View and Charleston East, we looked for a solution that would satisfy multiple criteria. Of course the system needed to perform well and demonstrate robust load-bearing capacity, but it also needed to be durable and efficient to construct. This means we prioritized a relatively quiet construction operation that was also eco-friendly. The solution is a pile foundation system consisting of 16- to 18-inch diameter drilled piers installed to depths of approximately 40 to 90 feet. The piers were installed using a soil displacement method that casts the concrete pile in place while generating essentially no drill spoils that would otherwise require offhaul and disposal. About 2,800 piles were installed for the Charleston East campus, and approximately 3,900 piles at Bay View.

Because of the speed of construction and the massive number of piles being installed, we needed to innovate ways to verify as-built integrity and performance of the piles since they couldn't be visually inspected underground. We developed a new method, which involves using automated data collection systems during installation that allow the operator and geotechnical engineer to observe the process in real time. We used additional techniques to verify the soundness of the piles, including full-scale load tests on selected piles and thermal imaging technology in freshly built piles to correlate the concrete's heat of hydration with

The geothermal loops at Bay View were installed by embedding them within the building's structural piles.

Eric Solrain of Integral Group surveys construction progress on the upper level of Bay View prior to installation of MEP systems.



A diagram of Bay View shows the geothermal system as it integrates with the structural piles.

"The canopy structure demanded we completely rethink typical engineering concepts for an office building. The key challenge was how to address the sheer volume of the building while maintaining efficiency and cost. While at first counterintuitive, we ultimately 'flipped' the building systems on their head, which led to an elegant solution we did not expect in displacement ventilation. Developed for theaters, the concept had never found its way to offices before.

Conceived together, displacement ventilation and geothermal heating and cooling enabled both systems to work: Because displacement ventilation allowed excess heat to be exhausted out of the canopy, it reduced loads and allowed the geothermal system to meet demands. Because geothermal stored waste heat from the summer to be used in winter, the added ventilation air needed for displacement ventilation to function properly could be provided while reducing energy demands.

Bay View has been a ten-year partnership – the largest, longest-running project in Integral's history. It epitomizes the growth we've experienced not just in size, but in capability, talent, and teamwork. As we like to say, the best ideas often come from the trades – and not just the engineers, but the pipefitters, sheet metal specialists, and those pulling wires. The collaborative and open-minded approach to the project was supported by a sense of radical ownership – as Sares Regis COO Yayu Lin would often say, 'It's up to us to deliver. Each of us.'"

—Eric Solrain, Integral Group, MEP Engineer, LEED Consultant

as-built pile dimensions. While typical methods rely on post-construction testing and evaluation, which often results in redundancies and inefficiencies, our method ensured integrity *during* pile construction. It's a new method that Google's director of infrastructure, Parham Khoshkbari, asserts can hold benefits for companies across the construction industry.

But back to the Bay View piles. Here we considered multiple options to activate the thermal mass below the building, including a shallow geothermal field with loops spread horizontally across the site 5 to 10 feet below the surface, and open loop systems that would tap into the sub-surface water. With the specific site conditions and project design, integrating the closed loop system with the structural piles held the highest potential for success. With the help of Integral Group and Southland Industries, we designed a closed-loop pipe system, embedded in the pile network, that connects to heat recovery chillers moving heat energy from one place to another. It's another example of our integrated approach to sustainable design, where every part of the building is doing more than one job.

Where typical buildings are cooled via evaporation in massive cooling towers filled with water, Bay View's geothermal system removes heat from the air and transfers it to the ground. This means we use 90% less water to cool the buildings than a traditional cooling tower system. In the winter, the geothermal system pulls heat directly from the ground to warm the buildings and heat our water. It's a system that doesn't burn any natural gas, and is four times more efficient than a conventional electric boiler. This especially helps reduce our carbon footprint in the winter, when the grid's carbon intensity is much higher. It also allowed us to electrify the building's overall systems more effectively, reducing the carbon intensity beyond what a simple electrically heated building could achieve. When compared with a conventional, code-compliant baseline, we estimate this geothermal system will reduce annual carbon emissions by about 50%.

All paints and coatings at Charleston East are low-VOC, from steel primer to millwork finishes. This not only improves the indoor air quality for building occupants, but also creates a less toxic construction site and supply chain.

Design for Circular Resources

Bay View and Charleston East are raising the bar on how we design for a circular economy that's consistently regenerative and restorative. We're extremely proud that Charleston East is slated to be one of the largest projects ever to attain an International Living Future Institute (ILFI) Living Building Challenge (LBC) Materials Petal certification, which helps ensure the health of the building occupants, the local community, and the broader supply chain. Thousands of materials on the project have gone through a rigorous sourcing and review process, we've aimed to eliminate all waste on the project, and at Charleston East we've also included over 30 salvaged materials and 100% FSC-certified lumber in the project.

A crucial step in designing for circularity is choosing materials that are safe for human and environmental systems, because we can't change the chemistry of materials once they are in our buildings.

Our interest in healthy materials goes back more than a decade, with our founders asking early questions about how building products affect the indoor air quality in our workspaces. Many chemicals in these common construction products have been linked to health conditions, and can leach into the environment to endanger the long-term health of ecosystems and communities. While it might seem simple enough to avoid these products, for many years the lack of transparency and information about materials' makeup and health impacts made it difficult for us (and others) to make informed choices. After years of leading our own internal research efforts to drive toward better material health, in 2010 we formally launched our Healthy Materials Program, which set out to eliminate hazardous chemicals from our tenant improvement (TI) projects. In 2015, we achieved our first LBC Materials Petal certification, for our Google Chicago project.

All of this prior work laid the groundwork for Bay View and Charleston East, where we vetted thousands of materials to ensure we were creating the healthiest spaces possible. "It was a whole new frontier to tackle the healthy materials effort at Charleston East in particular," says Lauren Sparandara, sustainability partner for Google's real estate division. "Here, we encountered completely new manufacturers and building materials, especially things people don't always think of because they aren't easily visible or traditionally exciting, such as the underground piping, or the insulation in the roof, or the coating on a current wall. There was a steep learning curve."

Beyond material health, we also applied rigorous standards at Bay View and Charleston East for the responsible sourcing of materials, such as the prior-

itization of local material sourcing and FSC-certified lumber, and for reducing construction waste. It's all part of our effort to ensure the projects embody our mission of creating environments that support human and environmental health. And it's not just about us. From the beginning, we've hoped our advocacy of healthier materials can help spark a conversation about materials across the industry, building momentum for standards that will move the market forward for everyone.

Healthy Materials

Health was front and center for every material decision we made on the project, particularly at Charleston East, where we targeted the LBC Materials Petal certification. This means the building's materials were thoughtfully selected to promote a materials economy that is non-toxic, transparent, and socially equitable. As part of this goal, every material installed at Charleston East was reviewed with the manufacturer to ensure it is free of LBC's Red List ingredients: 816 worst-in-class chemicals that negatively impact human and environmental health. That means all materials – from things you can see and touch, such as carpet and office chairs, to those less readily apparent, like underground pipes, curtain wall coatings, and the building's insulation – were carefully vetted with their manufacturers to ensure health was a driving factor in its selection. For example, at Charleston East we eliminated formaldehyde binders in the roofing insulation; worked to minimize BPA-based coatings; avoided hexavalent chromium coatings in the curtain wall; and replaced PVC pipe and conduit with better alternatives whenever possible. In total, more than 6,800 products were reviewed at Charleston East, with over 1,500 manufacturers participating in our effort to drive transparency in the building industry.

One case study where this played out at Charleston East is in the building's electrical infrastructure. If electricity is the lifeblood of a building, then the cables running through the walls and beneath the floors are its circulatory system. We peeled back the layers of this system to probe the health of this building's arteries. Conductor cable – which provides electricity to the building – contains a number of different materials, from the metal wire itself to insulating plastics and a protective sheath. At the time of Charleston East's construction, it proved impossible to entirely eliminate Red List chemicals in conductor cable throughout the building, particularly PVC and halogenated flame retardants. However, by working closely with a cable manufacturer, we supplied power to a suite of conference rooms in Charleston East with 100% Red List-free cabling. By proving healthy cabling is possible, we hope this prompts further scrutiny of the materials in electrical infrastructure and builds demand for healthy cables, ultimately moving the market toward better options that are accessible to all.

The Charleston East sustainability team toured local plastic recycling facilities to find a home for various plastic waste streams generated during construction. HDPE plastic products, such as conduit and underground plumbing, are melted down and reformed into new products.

Google, Building Product Ecosystems, and contractors tour the PABCO Newark facility site to explore opportunities for drywall recycling at Charleston East and Bay View. The project teams collected all gypsum wallboard scrap on-site and returned it to the facility to be manufactured into new drywall.

We also leveraged our learnings at Charleston East to inform the materials approach at Bay View. Focusing on interior products and high-impact core and shell materials, we sourced and reviewed over 3,000 building materials at Bay View to avoid those problematic Red List ingredients. The goal with all of this work is bigger than just Google's spaces and places. "The materials not only create healthy spaces, but also enable healthier and more sustainable product supply chains," explains Sparandara. By asking tough questions about the products in our buildings, we've influenced manufacturers to move toward safer chemistry and more transparent disclosure of material ingredients that benefits everyone.

Responsible Sourcing

Circular design aims to keep materials in use as long as possible, decreasing the demand for finite natural resources. With a flexible workspace environment featuring partition walls that can be easily adjusted, Bay View and Charleston East are designed to reduce the need for new materials as workforce needs evolve.

Additionally, Charleston East incorporates salvaged materials both into the building design and the artwork – such as reclaimed wood, bike racks, lockers, and tiles – that would have otherwise gone to landfill. At Bay View, reclaimed redwood from nearby Moffett Federal Airfield's Hangar One was used as a prominent interior finish element. We wanted to prove it was possible to build circularity into a project, even at the scale of these buildings.

Additionally, 100% of the lumber used at Charleston East (both temporary and permanently installed) was procured from responsibly managed forests certified by the Forest Stewardship Council (FSC). It's unusual to procure FSC-certified wood for temporary uses, but knowing temporary wood accounted for a large percentage of the total lumber on the projects, it was important to account for that footprint.

Prioritizing FSC-certified wood doesn't just mean the lumber we're using is responsibly sourced, but also that we're supporting larger efforts toward reforesta-

Plywood procured for Charleston East displays chain of custody documentation, verifying that it is from an FSC-certified forest. All wood on the project, even that used temporarily during construction, comes from responsibly managed forests or was salvaged.

tion. According to data compiled from the EPA, World Resources Institute, and the Climate Council, as of 2019, nearly 20% of all greenhouse gas emissions were the result of deforestation (accounting for more than the entire transportation sector), and 2 billion hectares of degraded lands (twice the size of the U.S.) have the potential for restoration. Ultimately, we believe healthier and responsibly sourced materials are not only fundamental to sustainable development, but also to the creation of a broader circular economy that's consistently regenerative and restorative.

Minimizing Waste

At Charleston East and Bay View, we implemented ambitious construction waste goals to avoid sending materials to landfills whenever possible. Charleston East also aims to achieve a net-zero waste target by diverting over 90% of its construction waste from landfills. As of October 2021, more than 22,000 tons of waste have been diverted, which is equivalent to diverting the weight of more than 11,000 cars. To do so, we implemented training programs for all workers on-site around zero-waste practices, and had dedicated staff who ensured all waste was properly sorted by material type. We also reduced waste from the start by leveraging prefabricated materials whenever possible so as to reduce scrap, and worked closely with manufacturers to minimize packaging wherever we could.

On both projects, we teamed with wallboard manufacturers to take back drywall waste to be reused as material in the manufacturing process. At Bay View, this closed-loop wallboard pilot prevented over 1.5 million pounds of drywall scrap – the weight of approximately 375 cars – from being sent to landfill. Similarly, at Charleston East we've recycled more than 530,000 pounds of wallboard waste – equivalent to more than 130 cars – and anticipate recycling much more through project completion. We also worked creatively to find new domestic recycling solutions for plastics. For example, at Charleston East we partnered with a startup to pilot their recycling technology on our plastic film waste, a notoriously difficult material to recycle.

Google's sustainability team meets with the contractor to see circularity principles in action. All field workers were onboarded to Charleston East's zero-waste goals – every team member played a role in minimizing waste from the project.

Design for Economy

We're the first to acknowledge that Bay View and Charleston East were driven by wildly audacious goals around innovation and sustainability in the built environment. But from the start, it was critical that whatever solutions we developed on these projects provide benefits not just to us, but to the industry at large, and to our local community. Our goal was for the projects to serve as pathways, opening new mindsets for what's possible in the built environment. "Right from the start, there was an idea that when you take on big, relevant challenges to solve something for yourself, it might actually be applicable and scalable elsewhere," says co-design lead Bjarke Ingels. It's our hope that these buildings serve as living proof – to our partners, other companies and building owners, and even ourselves – of what's possible when it comes to sustainable design.

Ultimately, the idea was to invest in bold ideas that create replicable solutions for a better future for everyone. "For me, whenever you are unlocking innovation, it brings with it questions of how you are aligning with the community and obtaining support from agencies to enable it," says Joe Van Belleghem, Google's global development senior director. "Our mindset is how to be a helpful neighbor and create solutions that meet the needs of those who live and work in the community." That's what we're focused on with our master plan vision for North Bayshore, a 120-plus-acre area of Mountain View that is poised to develop from a suburban office park into a place that prioritizes people, nature, and community connection. We wanted to design a place where our neighbors would not only feel welcome and invited, but that would also add value back into the community. We consciously approached every element of the buildings – energy, materials, landscape, construction, worker safety, and more – with the mindset to positively impact the economic ecosystems that drive our communities.

Modular Design

One way this philosophy played out in our architectural approach to Bay View and Charleston East was our systems-based thinking that prioritized modular design solutions. Wherever we could, we looked for opportunities to design in smaller parts, or modules, that could be built and constructed off-site. Not only does modular design lead to more flexible, durable construction in the long term, since parts and pieces can be easily swapped out without having to redesign the entire system, it also increases efficiency, quality, and safety during the construction process, while minimizing waste and risk.

At Bay View, we pursued modular construction solutions in several places. We wanted to build the 1,300-stall parking structure in the most efficient way possible,

Above, left to right: Lightweight, modular spaces are studied for areas of focus and collaboration. Florencia Kratsman of BIG (far right) tests a new space prototype.

"The construction challenges faced on the short-term accommodations at Bay View are not unlike many of the problems faced by multifamily housing projects across the Bay Area and California. Put simply, the cost to build is far too high. In today's reality, new housing projects are typically only feasible if they charge peak market rate rents. This is unsustainable for our industry and leads to extraordinarily cost-burdened families and individuals.

Our solution is straightforward: What if we build a home like we do a car? By applying manufacturing principles and the benefits of industrialization and standardization to the construction process, we have been able to successfully lower the cost and time it takes to build housing.

The Bay View project has had a tremendous influence on Factory_OS. From helping us scale operations to giving us an opportunity to test out additional offerings such as supplying FF&E (furniture, fixtures, and equipment), Bay View gave us a chance to build on and expand our capabilities. The future for factory-built housing is one that leverages the strength of strategic partners to help take this technological evolution to the next level, scaling its reach across the state and, more broadly, across the nation."

—Rick Holliday, Factory_OS, Manufacturer of Short-Term Modular Accommodations

so we worked with a company called Clark Pacific to precast all the concrete panels off-site in Woodland, California. The result was a dramatically reduced construction time – it took only 55 days to install the panels. Similarly, we employed prefabricated modular construction for the electrical rooms at Bay View. The 14 primary electrical rooms were fabricated, tested, and packaged by Modular Power Solutions in McKinney, Texas, before being shipped to Bay View and dropped into place in the building. "For all of these examples of prefabrication at Bay View, it was about asking, how can this propel our industry forward?" says Yayu Lin, COO of Sares Regis Group Northern California, Bay View's development manager. "We wanted to show that these kinds of innovations can actually yield a payback for market developers who need to make a return on their investments."

Finally, we prioritized modular construction for the 240-unit, short-term employee accommodations at Bay View. Partnering with Factory_OS, a Bay Area modular housing manufacturer, the units were fabricated off-site in a factory setting that was more cost-effective, reducing material waste and carbon emissions. Beyond these suites, we're investing in Factory_OS to help deliver on our Bay Area housing commitment that aims to catalyze 20,000 homes in the region by 2030. "We saw the role that Factory_OS could have in the marketplace to provide lower construction cost solutions to affordable housing projects, and help spur affordable housing in the entire Bay Area," says Van Belleghem of the partnership. Read more on Factory_OS later – it's a tangible example of our goal to design solutions that add value back into the community in more ways than one.

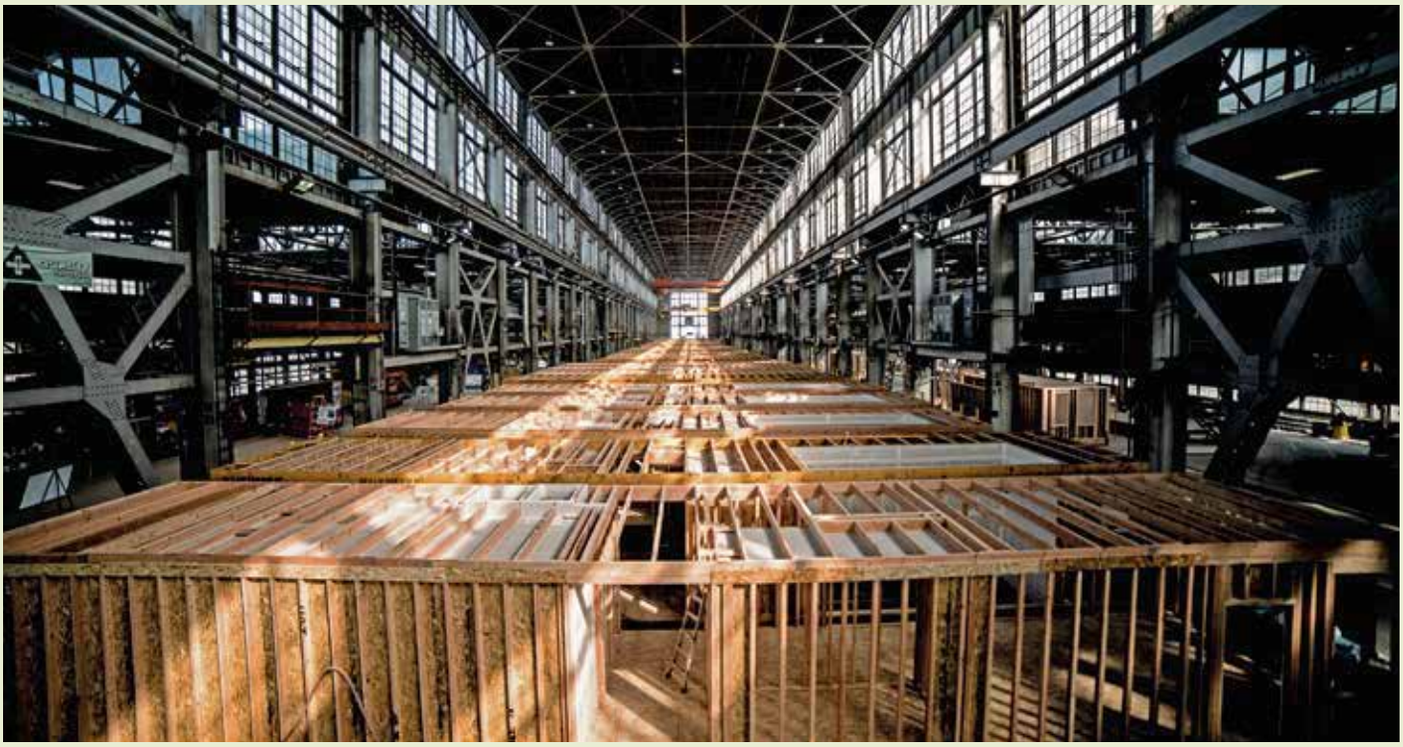
Replicable Solutions

From the start, we hoped this project would shift the industry's mindset around what's possible for sustainable, regenerative buildings. "The innovations on these buildings had to be healthy and high-performing," explains Michelle Kaufmann, Google's director of R+D for the built environment. "But we also wanted the solutions to be scalable to the whole industry, so we looked closely at cost." Thomas Heatherwick, co-lead design architect, agrees. "We had to argue for the value of everything we proposed. There was an exhaustive process of analyzing value in every single bit of the project."

Elements such as the dragonscale solar, on-site wastewater treatment at Bay View, and construction waste minimization strategies are replicable solutions that we're hopeful others will learn from and continue to evolve in future projects. For us, Bay View and Charleston East are blueprints for future innovations – starting points for what's to come. "Early on, we framed them as living buildings," says Radcliffe. "We've always thought of them as the beginning of a journey."

ConXTech's modular steel building system was utilized on Bay View and allowed for rapid steel installation. As an added benefit, the bolted ConX nodes are robust enough to completely exclude intrusive diagonal bracing.

Prefabricated modular units arrive at Bay View and are readied for stacking as part of the short-term corporate accommodations.



An interior view of the Factory_OS operation in Vallejo, California, where the company produces prefabricated modular housing units at scale.

Nature

At a fundamental level, the well-being of people depends on the health of the planet. That's why at Bay View and Charleston East, we stepped back to ask: How do buildings work with nature? Instead of being separate from natural ecosystems all around us, can our buildings harmonize with the evolving environment? Our goal is to create campuses that benefit both people and wildlife, and contribute to the ecological health of the region. When we design regenerative places and spaces that give back to their environments, we hope everyone who experiences them can gain a greater understanding of the value and functions of natural ecosystems.

A view of Bay View across the ponds adjacent to San Francisco Bay.

An aerial rendering showing the three canopies at Bay View and the larger site.

Water Positive

As we work toward our companywide goal to replenish 120% of the water we consume by 2030, Bay View and Charleston East have been case studies in how to apply this goal to new buildings we construct. Both projects use natural and engineered techniques to save on water consumption while also preserving the surrounding ecosystems. Bay View is on track to be the largest project in the world to achieve LBC Water Petal certification, meaning the project meets LBC's definition of net-positive water. All of the site's non-potable water demands will be met using the recycled water we generate on-site, with the opportunity to export excess to others and further offset potable demands. At both Bay View and Charleston East, we've prioritized infrastructure that captures, treats, and reuses significant quantities of water on-site, and we've replanted hundreds of native plants and over 400 native, drought-resistant trees, saving on water use for irrigation. Our water strategy embodies our holistic approach to sustainable design, where the goal is to use less and minimize waste. "One of the key principles early on was to look at solutions that are multifaceted," explains Mary Davidge, former director of global design. "For example, the water retention ponds at Bay View not only collect water for reuse, but also provide habitat restoration, sea level rise protection, and access to the beauty of natural wetlands for both Googlers and the public on the Bay Trail."

Stormwater Catchment and Reuse

Over the years, drought has become ubiquitous across California. But we know that how we choose to build today can have major impacts on access to water for our communities for generations to come. For us, the first step is to design systems that greatly reduce water demands. At Bay View and Charleston East, the strategy focuses on reducing the buildings' demand for water in the first place, using integrated water conservation strategies, which in turn "right-size" the amount of water we then need to capture and reuse. "It was about looking at the community benefit of these projects through the lens of using less and sharing more," says Asim Tahir, Google's director of energy and carbon.

At Bay View, we've built our own on-site system to collect, treat, and reuse all stormwater and wastewater. This treatment system includes a series of interconnected, above-ground ponds that capture stormwater runoff year-round. The design simulates naturally occurring ponds and their hydrological patterns at the edge of the bay. When treated stormwater is drawn down from some of these ponds, it enters our treatment system, where it combines with treated wastewater from the buildings to become a sustainable source of water for cooling towers, flushing toilets, and landscape irrigation. This means all non-potable water demands at Bay View – that is, water that's not drinking

quality but can be used for those other purposes – will be met using the recycled water we generate on-site. Even more, during certain times of the year, Bay View will generate more non-potable water than it needs, meaning we can have the opportunity to export the excess recycled water so others can reduce their potable water demands. "Being at the edge of the Bay, water was truly a theme for the project," says Drew Wenzel, Google's district systems water lead. "Achieving this level of performance to generate excess non-potable water required collaboration and innovation across many disciplines: energy systems, plumbing, landscaping, and water treatment."

Over at Charleston East, we're collecting rainwater from the roof that can be used for non-potable needs like irrigation and toilet flushing. Basement cisterns at Charleston East can store 720,000 gallons of rainwater, which is more than fits in an Olympic-sized swimming pool. In another example of our integrated design approach, locating the cisterns in these spaces meant we were tapping otherwise unused space that would have simply remained empty. These innovative approaches at Charleston East will reduce our potable water usage on that campus by 40%. "Together, we hope Bay View and Charleston East set a new bar in water performance that other projects in the region can learn from and exceed," says Wenzel.

Geothermal Piles

Bay View goes a step further by also incorporating the largest geothermal pile system in North America to help heat and cool the campus. Usually, the largest water use in developments is in cooling systems. The way buildings typically reject heat is through cooling towers, which pull heat from the building and evaporate it with water. We know this is a poor use of water, particularly in our region. Instead, Bay View's geothermal system rejects the campus' heat not through water, but through the ground below us.

Utilizing the existing structural piles at Bay View for the geothermal system is yet another example of the integrated design elements we optimized on the project. Of Bay View's 3,900 structural piles, 2,200 are utilized for geothermal and contain embedded

"Infrastructure, user experience, and ecology are thoughtfully and elegantly woven into the design and engineering of the Bay View campus. An exemplary design team went to great lengths to understand one another's constraints and opportunities, and worked collaboratively to achieve a host of co-optimization solutions for this high-performance landscape system. It's poised to simultaneously relate ecologically to the San Francisco baylands, while functionally providing stormwater, wastewater treatment, and water supply functions. All of this achieved within the context of a high-density campus that also must deliver human use intensity.

The simplicity and functionality of this high-performance landscape at Bay View is the perfect counterpoint to the bold and technical presence of the modern buildings within it. This marriage between emerging technical approaches to architecture and nature-based solutions represents hope for a positive future in which technology and ecology exist in harmony, producing positive outcomes for natural and human systems.

Because the integration of on-site water infrastructure with larger surrounding districts is nascent at this scale, Bay View provides a laboratory for better understanding the regulatory, financial, and technical components of such an endeavor. This can inform public/private partnerships, capital planning, and financial mechanisms for developer participation in sustainable water management planning and operations."

—Josiah Cain, Sherwood Design Engineers, Water and Wastewater Consultant

pipes connected to heat recovery chillers that move heat energy from one place to another. These heat recovery chillers connected to the geothermal system also generate domestic hot water for the buildings. In the winter, we recover heat from the ground and use it to warm the building. In the summer, we cool the buildings by capturing heat from the air and, instead of evaporating it with water, transferring it directly to the ground via the geothermal system. This means we're able to reduce the amount of water used for cooling at Bay View by a whopping 90%, which equates to 5 million gallons of water annually.

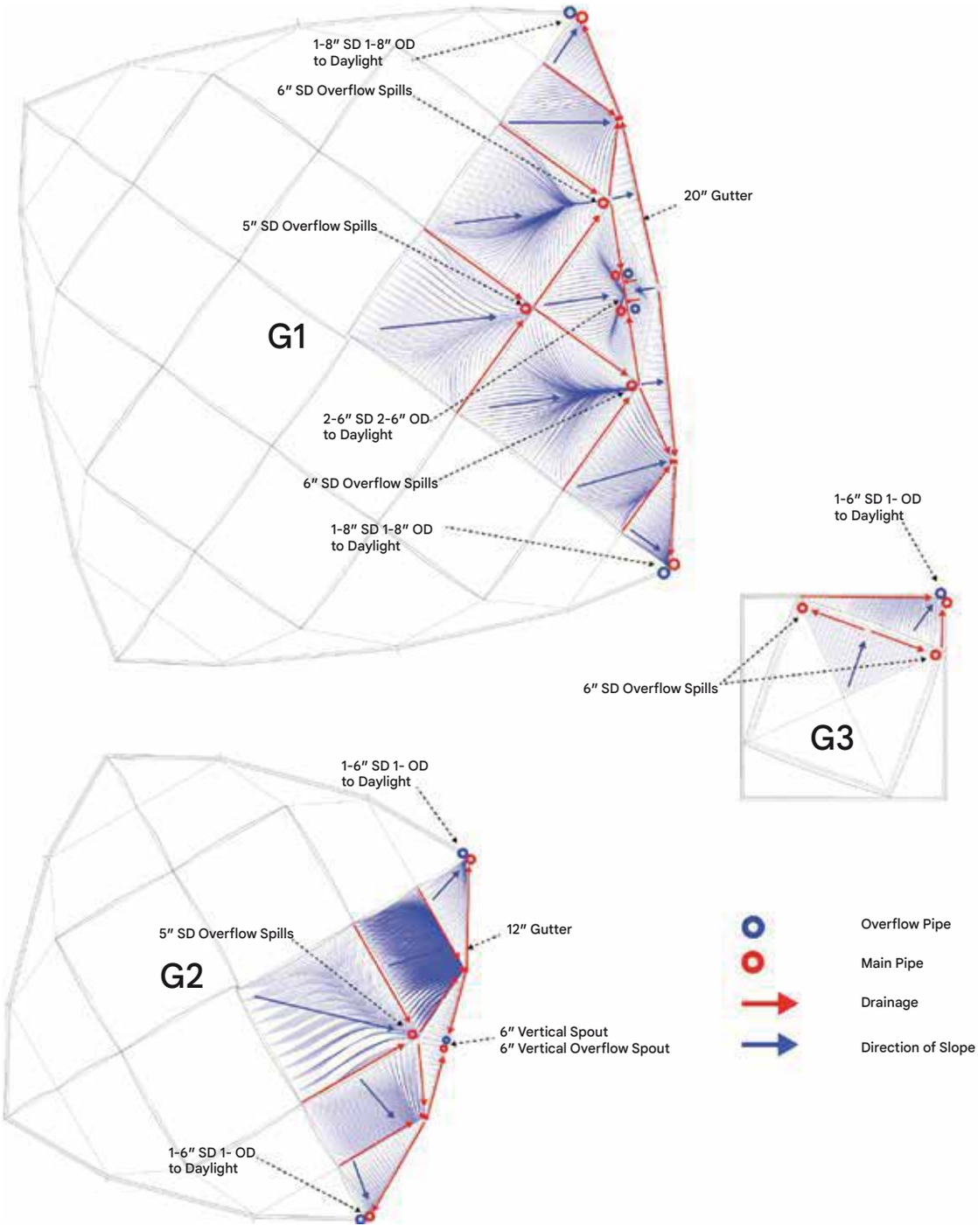
Wastewater Treatment

The final step in our water-positive approach at Bay View has to do with how we treat wastewater on-site. Typically, buildings send all of their wastewater to sanitary sewers that feed back out to municipal treatment systems. At Bay View, we've closed that loop within the project. An on-site wastewater treatment system treats all of the campus' wastewater from restrooms and kitchens to be reused for the projects' non-potable demands, including toilet flushing, irrigation, and cooling towers.

The regional division of the State Water Resources Control Board permitted the Bay View wastewater treatment system, but we hope Bay View will pave the way for local codes to evolve, making it easier for us and our neighbors to design and include these wastewater treatment systems in the future. "The more of these systems, the better, because it changes people's perceptions of what wastewater treatment can be," says Kate Turpin, director of design performance. "Together with stormwater treatment, it shows that these systems can be an incredible experiential element of a site when they're done thoughtfully, and can add biological richness and diversity."

A rendering studies the ecology of the Bay View site as it aims to be net water positive.

2.2 DRAINAGE STRATEGY



A diagram looks at the drainage strategy of the Bay View sites.

Near to Charleston East, Google helped the City of Mountain View realize the 6-acre Charleston Retention Basin in 2017.

Resilient Ecology

We know that humans have an inherent affinity for nature. When our eyes observe greenery, cortisol levels and blood pressure decrease, and it stimulates areas of the brain associated with creativity. But it's not just about people – we also know that healthy, diverse ecosystems are essential to creating landscapes that can withstand the stresses of climate change. With the development of Silicon Valley, many of the ecological functions of the region have been changed or lost entirely. That's why our designs for Bay View and Charleston East were centered on regenerating local biodiversity and resilience.

"The goal was to develop both of the project sites in a way that integrated with the landscape and would help restore the land to make it more resilient," explains Mary Davidge, Google's former director of global design. To us, "resilient" means places that contribute to the long-term ecological health of the region, where both people and wildlife can thrive even as climate changes. "Resilience requires the whole system to be connected and interworking," says Robin Grossinger, who consulted on our ecological approach at Bay View and Charleston East as co-director of the Resilient Landscapes Program at the San Francisco Estuary Institute (SFEI). Throughout, we prioritized multifaceted ecological designs that bolster biodiversity and regenerate natural habitats, while also contributing to biophilic and beautiful interior and exterior spaces.

Biodiverse Landscapes

Bay View and Charleston East are in a prime position to help transform the ecological health of Silicon Valley and the South Bay region. That's why we sought to design both sites as innovative urban habitats that would benefit the ecological health of the region by responding to the particularities of each campus' unique context.

At Charleston East's 18-acre site, four acres of which are vegetated, we worked to reestablish historical ecosystem elements that provide critical support for wildlife, yet have been eradicated from the region over time. The landscape design creates habitat that mimics natural habitat native to the region yet largely long gone from the Valley today, including oak woodlands, willow groves, chaparral, and grasslands. There is also a bioretention area on-site that will capture and filter stormwater and urban runoff, and the landscape palette is composed almost entirely of native species, including 380 native trees, with special attention given to supporting native pollinators. Over 90% of the plants

at Charleston East provide nectar for local pollinators throughout the year. Native milkweed, the host plant for the threatened Western monarch butterfly, will be strategically planted across the campus to provide critical breeding habitat and food source for monarch caterpillars. It's part of our larger initiative to help restore pollinator habitat in California – in 2021, we donated $1 million toward creating habitat for monarchs and other pollinators, like native bees and other insects across California. This effort is particularly crucial in the context of the precipitous population declines facing Western monarch butterflies and other insects, increasing the urgency of creating natural areas for these species to flourish.

Another key piece of our ecology strategy at Charleston East has to do with one specific type of tree: oaks. We worked with local scientists to design a connected canopy for the landscape that includes 142 native oaks, along with other tree species including madrone, sycamore, and willows. Before 1900, native oaks were common in California's valleys and were the characteristic tree of Silicon Valley. But to reproduce successfully and support wildlife like acorn woodpeckers, they need to be planted in connected networks and nodes. Our native oaks support a far greater diversity of native wildlife, such as birds and insects, compared with the non-native trees typically planted in urban landscapes. Reintroducing native oaks to the South Bay is also a key strategy for building ecological resilience in the region: Native oaks are uniquely adapted to withstand the Bay Area's increasing climate challenges of drought and extreme heat. In ten years, we estimate this oak network will provide 80,000 square feet of connected tree canopy at Charleston East. To help bolster a safe environment for birds attracted to the ecologically rich landscape, windows on buildings across both Charleston East and Bay View feature integrated visual patterns, so birds perceive the glass as an obstacle to be avoided.

Wetland Restoration

Bay View sits just a stone's throw from the San Francisco Bay, so it was important that we design the landscape here with an attitude toward regenerating wetland ecosystems. We've created 17.3 acres of high-value native natural areas at Bay View – including wet meadows, woodlands, and marsh – all part of our larger effort to support regionwide efforts to reestablish high-value natural areas and rehabilitate Bay Area wetlands. "I remember walking the Bay View site at the start of the project and realizing that most development in the area had turned its back on the Bay, and that we had an opportunity here to restore that connection," says Davidge.

Bay View's landscape is a key component of the project's ambitious water strategy, which generates

"SFEI has served as an ecology advisor for projects in North Bayshore since 2014. Our job was to develop a science-based, locally specific framework for regenerating the ecology of the area through Google's projects.

When we began our work, we found there were several critical ecosystems that used to be characteristic of the Santa Clara Valley, but were almost completely gone. We then worked directly with design teams to figure out how to translate and integrate those ecosystems into the building sites to meet the needs of stormwater management, shade and temperature modulation, landscaping, and outdoor experience. Through Bay View and Charleston East, we're bringing back the missing natural heritage of the region, including the distinctive valley oak savannas, the lush willow groves, and the beautiful wildflower pollinator meadowlands. Unlike many projects where ecology can be an add-on or perceived hindrance to the design goals, these projects drew deeply on the local ecology as a source of creativity and inspiration."

—Robin Grossinger, San Francisco Estuary Institute (SFEI), Ecology Advisor

A view of Bay View in the distance beyond Stevens Creek.

"There was a tremendous amount of earth shaping and moving for Bay View. This was for several reasons: the required finish floor elevations of the buildings and existing grades; the size and footprint of the buildings; and to keep all the exterior circulation fully accessible. Also, existing sub-grade conditions required some innovative technical/structural/geotech landscape solutions to avoid long-term settlement and subsidence.

The capture, cleansing, and reuse of rainwater was also complex at Bay View, as were the significant ecological environments and habitats there that needed protection and enhancement. Finally, the central courtyard at Bay View is built over occupied space, so thriving soil-depth conditions to accommodate large caliper trees needed to be designed. The solutions are all interrelated, as we were designing holistic solutions to larger landscape and ecology questions at Bay View.

The most exciting aspect of this project was solving the above complexities, and then getting it built, all in a collaborative environment. I believe every project influences the work of the next because learning is always cumulative. However, this project especially highlighted the value of being open to and participating in a truly collaborative process."

—Susan Weiler, OLIN, Landscape Architect

more non-potable water than the site needs, in part through a series of ponds that capture and treat stormwater. The significant amount of open space at Bay View is thoughtfully designed to echo pre-development water flows through these stormwater treatment areas, which include open-water ponds that provide habitat for aquatic wildlife. These ponds are integrated with the larger landscape design, which includes a diverse mosaic of wetland habitats, including wet meadows, willow groves, and emergent perennial wetlands. Because Bay View is situated in close proximity to the baylands, ground water is relatively shallow and able to support wetland and riparian ecosystems. New willow groves along the stormwater ponds – a critical habitat for local wildlife and migrating songbirds, which have almost entirely disappeared from the South Bay over the past centuries – provide essential areas of rest and resources for a variety of resident and migratory birds, insects, and other wildlife. Bay View's landscape does its part to help reestablish essential natural areas for the region.

Ecology Education and Community

The idea at both projects was to use landscape design to create a sense of place, both for Googlers and the larger community. In this way, the campuses can foster ecological awareness and appreciation, encouraging environmental stewardship by helping educate people about the value of local natural ecosystems.

At Bay View, walking paths wind through the storm-water retention ponds and connect to regional trail systems, offering Googlers and visitors direct access to these restored habitats, many with panoramic views of the Bay. In addition to the ecological initiatives at Charleston East, 20% of the site is accessible to the public and dedicated to promoting urban agriculture, featuring new demonstration garden beds, flowers, and bee boxes. "It's about trying to give something back to these places that they didn't have before we started," says David Radcliffe, head of real estate.

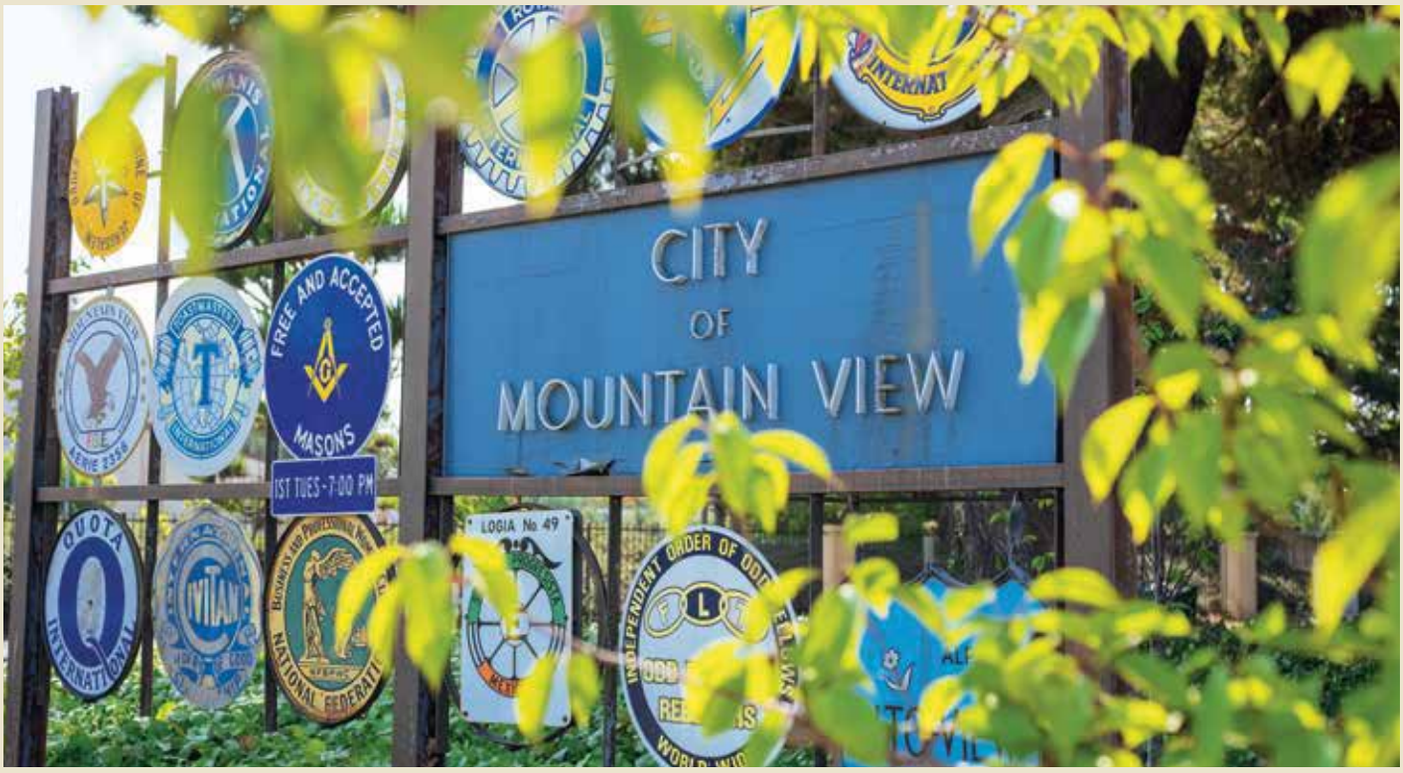
Ultimately, as much as Bay View and Charleston East reflect Google's ecological values, they also represent the larger values of a region that's done a remarkable job of protecting and conserving broad swaths of the hills and Bay, and is now working to green the urban landscapes where so many live and work. As Sarah Gill, our district workplace design lead, puts it, "The buildings, as well as the work Google is doing in the South Bay, are trying to ensure that when we build, it reflects a sense of environmental responsibility."

Images showcase native plantings that were thoughtfully selected in an effort to support local ecology.

Community

At their heart, the places we design are about people and the connections between them. We know the decisions we make on our projects have a ripple effect on the people and places around us, which is why we're always looking for ways to be stronger, more supportive community members. At Bay View and Charleston East, we aimed to design vibrant, inclusive spaces and places that respond to their local context and create benefits for everyone. Because if our local communities thrive, we thrive, too.

An early rendering shows the public plaza at Charleston East.



A welcome sign to the City of Mountain View, where Google's headquarters is located.

Connecting the Community

From our commitments to expand opportunities in the community to the economic impact of our presence, we're constantly looking for ways to be community partners. With new developments like Bay View and Charleston East, our goal is to create vibrant, welcoming places that lead the way in sustainable design and are mutually beneficial to local communities and Google. No matter what, we're always striving to be a helpful neighbor. That's why at Charleston East, we focused on creating an inclusive and inviting community hub for the neighborhood and Googlers. At Bay View, the landscape design incorporates connections to local trails so that everyone can access the beauty of nearby wetlands. To us, these projects were not just about designing the best places to work, but about building new pathways for connection that help our local communities thrive.

Vision for North Bayshore

We've been proud to call Mountain View our home for over 20 years. Now we're working with the City and community to reimagine over 120 acres in the North Bayshore area of Mountain View into three new neighborhoods that prioritize people, nature, and community connection. Bounding this area just to the north is Charleston East – our first step in putting these principles of sustainable, community-minded development into action.

"We're asking how these places can have a positive environmental and social impact on everyone they touch," says Joe Van Belleghem, Google's senior director of global development. With Charleston East, we were thoughtful about weaving the building into its context via exterior and interior design elements. Snaking around the building and through the 18-acre site is a dedicated Green Loop with bicycle and pedestrian paths. Here people can enjoy the native landscaping, urban agriculture garden beds, and public art that makes up the building's exterior public spaces.

On the west side, the building opens to the adjacent city-owned Charleston Park, welcoming the public to Charleston East with spaces and experiences for everyone to enjoy. With over 10,000 square feet of public space, Charleston East's ground floor contains new retail and food experiences, as well as a year-round neighborhood partnership center. A casual spot for day-to-day interactions, this neighborhood center will also host a range of events and workshops to highlight local small businesses and community organizations. It offers an inclusive center for dialogue and learning, while serving as a social node for Charleston East and the broader North Bayshore neighborhood.

These interior community spaces connect to a large outdoor public plaza at Charleston East, where we

The Mountain View Farmers Market bustles with activity.

plan to host neighborhood events like farmers markets, food trucks, and live music. This public plaza will help foster social and meaningful connections among the community and Googlers, and aims to support local and diverse businesses, community groups, artists, musicians, and more. There will also be six pieces of public art throughout the plaza, several of which are from local artists, and plenty of public seating. "Charleston East is the start of a new kind of community engagement in Mountain View," says Chris Alwan, director of corporate real estate development.

Charleston East represents the beginning of a longer journey to create a greater sense of place in North Bayshore by transforming an office park into three complete neighborhoods, with thousands of homes and nature everywhere. After years of listening and learning from the City and surrounding community, our North Bayshore Master Plan focuses on housing, sustainability, habitat preservation, economic development, and mobility. The plan proposes up to 7,000 new homes, 3.7 miles of new hiking and biking trails, 31 acres of public open space, and nearly 300,000 square feet of public retail and community spaces. Like Charleston East, our vision for North Bayshore underscores the need to create opportunities for all people – Googlers and community members – to connect and engage with one another.

Multi-Modal Transportation Connections

At Bay View and Charleston East, our community commitments have also manifested in improvements to public transportation networks and sustainable commutes. To improve how people navigate North Bayshore, we've worked with the City of Mountain View to build the first phase of the Charleston Transit Corridor, which will encourage public transit, increase bike and pedestrian safety, and make it easier to get around North Bayshore without a car. As part of the Charleston East project, two transit centers were constructed on Charleston Road, adjacent to the campus. These facilities, along with the planned bus-only lanes on Charleston Road and Shoreline Boulevard, will enhance the transit options in the area.

The Charleston Transit Corridor also features world-class bicycle and pedestrian pathways – including Class IV separated bikeways, also referred to as cycle tracks. Inside the building, we're encouraging "two wheel" commuting with 780-plus bike parking spaces, along with bike lockers and showers.

We've expanded our bike, walking, and shuttle bus routes and stops at the Bay View campus to prioritize non-car traffic. At both Bay View and Charleston East, we plan to continually improve the mobility potential of each site.

Investing in Replicable Solutions

To us, sustainable design is about integrating people and place in a way that benefits both humans and the environment. That's why as part of our Bay View campus, we partnered with Factory_OS, a modular housing manufacturer, to construct short-term accommodations for our corporate housing program.

As Rick Holliday, co-CEO of Factory_OS, recalls, "When Google first approached us, our company was just coming into form. Working with Google on this project gave us footing to grow our business and train up a robust workforce of union carpenters." After three years of scaling the business and developing a highly efficient manufacturing process, Factory_OS was brought in to manufacture the entirety of the 240 short-term employee accommodation units.

The modular design of these units allows for off-site construction in a factory setting that reduces material waste, carbon emissions, and is cost-effective. The result is an opportunity to decrease construction costs in a controlled environment and increase speed to market, while delivering innovative, well-designed and tech-ready multi-family homes and buildings. Whether people are here for meetings or relocating to the area, the short-term employee accommodations are an on-campus amenity that fosters connection and collaboration, while eliminating travel time and reducing traffic congestion.

Beyond these suites, we're working with Factory_OS to help deliver on our Bay Area housing commitment that aims to catalyze 20,000 homes in the region by 2030. In 2020, we invested in Factory_OS to double its production by building a second factory that will help create tens of thousands of homes over the next decade. As of June 2021, our investment helped Factory_OS deliver 1,500 homes in the Bay Area. As Holliday notes, "Helping move the industry forward takes not only a good idea, but a strong coalition of partners who are committed to helping make a difference on the cost of housing."

Not only does Factory_OS offer efficient and effective manufacturing practices, they're creating more local jobs and training underserved communities who want to have opportunities to grow their skills. Finally, Factory_OS also utilizes sustainable building processes and requires less site travel, which helps reduce their carbon footprint. For Joe Van Belleghem, senior director of global development, the collaboration with Factory_OS underscores the need to approach innovation through the lens of community. "It's an innovation mindset of creating a shared value among all partners so that everyone wins," he says.

Kayaks at the Shoreline Lake Boathouse in Mountain View, California.

Cyclists zoom along the San Francisco Bay Trail that Google has helped enhance.

Renderings of Google's master plan vision for redevelopment of North Bayshore as three complete neighborhoods with 7,000 market-rate and affordable homes.

At Bay View, a work by Google artist-in-residence Victoria Wagner.

Site-specific art in Bay View courtyards offers moments of surprise and delight, while also doubling as wayfinding.

Art

We believe the best places to work are functional and healthy, but also provide multisensory environments that offer moments of surprise and delight. It's the intangible third dimension that helps us feel engaged, alive, and comfortable by reminding us of our shared humanity. Dedicated art programs at both projects help tap into this humanistic element, while also contributing to placemaking and wayfinding.

Across the board, when it came to art, a key inspiration was Burning Man and the site-specific, evocative art installations that pop up during this annual event in the California desert. We looked to many of our favorite artists from Burning Man as we shaped the art solutions for interior courtyards at both Bay View and Charleston East, all with the intent to establish a workplace centered around experimentation, making, and creative explorations, where Googlers can feel energized and inspired. At Charleston East, six exterior public artworks by local artists – all built with healthy materials – help extend this directive to public spaces open to the entire neighborhood.

At Bay View, Google's Artist in Residence Program brought nine artworks by local Bay Area artists to the interior of the main office building. Located on and around the nine massive two-story elevators dotting the interior, the artworks provide placemaking moments – for Googlers and visitors alike – to delight in custom, site-specific murals.

The Bay View artists responded to the theme of "Everyday Ecology," recognizing the interconnectedness of our daily experiences of ecology. Each artwork integrates into dedicated "ecological zones" within the building, acting as gathering spaces and focal points inside, while also encouraging human interaction with the outside world. The nine original artworks reflect qualities of innovation, surprise, and delight, as well as a connection to nature.

Each mural at Bay View encapsulates a specific biome, creating not only a unique artwork, but landmark wayfinding moments. The five biomes are grasslands, scrubs, dunes, oak/savanna, and tidal/marsh. The resident artists include Rachel Kaye, Tess Rubinstein, Laurel Picklum, Victoria Wagner, Adrian Arias, Mariangela La Thanh, Brett Flanigan, Carmen McNall, and Amandalynn. The cohort was selected for their representation of connections to the specific ecologies in the Bay Area, and all focused on using eco-friendly materials to bring their artworks to life.

For artist Rachel Kaye, the tidal/marsh biome was the main source of inspiration. “I played around with shapes found in the tidal/marsh environment, then broke down those shapes to create a quilt-like effect. Abstraction that hints at the familiar has always interested me because it takes the viewer to a place where they look for clues of origin.” Artist Amandalynn looked to nature as a vehicle for bringing people together. “I chose to illustrate a mixture of local flora and fauna intertwined with grasses and vines, depicting the natural flow of growth and pollination. Through use of color and imagery, this piece is intended to bring a sense of connection to the natural environment, as well as create a beautiful and comfortable place to gather and create.” For artist Mariangela La Thanh, the inspiration came from her immediate context. “I painted the familiar landscape that surrounds my home in a deeply rural area of Mendocino, California – during long summers, it looks like an endless dry grassland full of rocks and thistle. My mural is an attempt to recreate a space where the viewer can lose their sense of time and direction for a moment. Both sky and earth are filled with clouds that are constantly changing, moving, and circling back to where they were.”

Nine artworks were commissioned by Google artists-in-residence and responded to the theme “Everyday Ecology.” Clockwise from top left, artists included Rachel Kaye for the dunes biome, Amandalynn for the Grasslands biome, Mariangela Le Thanh for the scrubs biome, and Laurel Picklum for the tidal/marsh biome.

A construction briefing takes place before the day gets going, with Todd Phan of Southland taking the lead.

Collaboration

In many ways, the most important ingredient in the Bay View and Charleston East project has been collaboration. To complete a project of this scale and ambition, we knew we had to radically rethink the typical process of putting together a building so we could unlock the highest degree of innovation from everyone involved. "First and foremost, this project was about making sure we had highly integrated teams," explains David Radcliffe, vice president of our real estate division. "The construction process has historically been very serialized, and we knew we needed a much higher degree of integration here."

Processes and Partnerships

From the start, crafting an integrated project delivery model was a top priority, and ultimately became the key ingredient for the success of our expansive project team, which numbered in the thousands. Working alongside us, designers, engineers, builders, consultants, and specialists gave input at every point of the process on how to achieve our common project goals around innovation, nature, and community. "We knew we needed a team that was focused on working together to collectively design and provide construction solutions," says Kevin Antonelli, director of construction and former development executive for the project. "The team had to be united in every way."

We began by bringing together two of the world's most forward-thinking architects to collaborate on the design: Danish architect Bjarke Ingels of Bjarke Ingels Group (BIG) and Thomas Heatherwick of London-based Heatherwick Studio. "We scoured the world looking for a special architect who could really do something different," says Radcliffe. "Ultimately, we ended up with who we believed were the two best-in-class with BIG and Heatherwick." Together, these boundary-pushing architects worked alongside engineers, builders, and a host of consultants in a highly integrated process where we matched big design ideas with equally innovative, trailblazing strategies in engineering and construction. "In many ways, we were figuring out how to construct the buildings in real time as we were designing," says Kavi Singh, development executive on the project. "For that reason, the collaboration between the designers, the contractors, the engineers, and the manufacturers and material folks had to be very close. It's not an exaggeration to say the construction of these structures was a feat in and of itself."

Throughout, we looked to bring together the pragmatic, practical thinkers and builders with the dreamers and visionaries. "This was among the most complex developments we've been involved in, and we carefully crafted a team with the requisite experience and

"Our role on the project was architect of record, which is sometimes called executive architect. We produced all the contract documents and documents for submission on Bay View and Charleston East – which encompassed everything from how to get city approvals to how to build the buildings. We've been doing this work with design architects for over 40 years and have developed a technique which often sets the pace for the project.

We regularly work with multiple designers, as we did on this project, and while we often see architects compete rather than collaborate, this project was different. There was a creative tension that actually worked in everyone's favor. Knowledge moved back and forth between Bay View and Charleston East, and each one would get progressively better because of what we learned on the other. Adamson was common to both projects, so we could look across.

We also relied heavily on our teams of consultants, which were for the most part unique to each building. I often described it as an ongoing discussion, or one very long conversation. It was like stepping up a ladder – an evolution that meant we were progressively making each project better."

—David Jansen, Adamson Associates Inc., Architect of Record

A team of contractors problem solve at Charleston East.

Contractors continue the installation of the dragonscale solar skin.

"It was an exciting challenge to solve the puzzle of Charleston East, completing the construction and being a part of a team on such an innovative design project. Atypical construction projects like this one provide new and exciting challenges not normally seen in this industry or in the region. The biggest challenge – one that required creativity and collaboration from all project team members – related to the design and construction of the canopy structure. It was a process of managing structural steel deflections, the complexity of the BEMO roofing system, integration with the photovoltaic panels, and their impact on the overall budget and schedule.

The future of the workplace is all about flexibility, bringing the outside and inside together, while also providing security. We're excited about the innovations achieved on these projects that allow for future movements and modifications of office furniture layouts, and give employees a strong connection to nature even when inside.

We hope this project will demonstrate to the A/E/C industry the capabilities of a multinational collaboration during a global pandemic to deliver a world-class project. Unique projects like this one call for engineers to develop new systems and tests to evaluate hypothetical models versus real-world conditions. And for contractors, this project demonstrates the necessity to correctly buyout the project with subcontractors who can perform the necessary tasks."

—Daisy Pereira, Devcon Construction, General Contractor

attitude to contribute every day toward completing it," says B. Timothy Desmond, project executive at PMA, development manager for Charleston East. "We realized early on that a proactive approach to problem-solving and collaboration within the entire project team would be the winning formula for a successful project." Today's building problems require diverse perspectives and experience, and in many ways, we found the most important element to success was simply providing space and time for subject matter experts to have a conversation. "It was about creating an environment where people aren't just advocating for their interests, but feel like they are going to own the whole," says Sarah Gill, district workplace design lead. "A lot is possible with unexpected collaboration."

Worker Health and Safety

A key goal on the project was to prioritize the human experience, for those occupying the buildings and for those constructing them. With millions of person-hours on the construction of the projects, spanning more than five years, we knew we needed to create an excellent work environment for the contractors, just as we were striving to do for Googlers occupying the completed spaces. "To me, a key aspect of innovation on our construction sites was to support productive and safe worksites that focus on the well-being of construction workers," explains Joe Van Belleghem, global development senior director.

To support construction workers at Bay View and Charleston East, both sites were union labor projects. We are proud that the safety record on both projects was significantly better than national averages. Additionally, we partnered with the American Heart Association to create a culture of healthy living for the workers through their "Hard Hats with Heart" program. This includes educational programs focused on everything from eating smart to stress reduction, safety training, heart health, blood pressure testing, and more. It's our way of supporting the on-site ingenuity that we so often witnessed from workers over the course of construction, where crews were often called upon to solve "last mile" questions on converting geothermal, dragonscale solar, and so many other design innovations into reality. "We greatly value the individuals who build our projects. Skilled workers, focused on safety, lead to better outcomes," says Van Belleghem, acknowledging our deep gratitude for the thousands of workers and trades-people who built the project from the ground up.

Construction teams work on the structural components of Bay View and Charleston East.

At Google's R+D Lab for the Built Environment, new concepts are tested to improve equity between those in person and those on video.

Future

Our emphasis on designing adaptable, future-ready spaces underscores our belief that workplace and user needs will continue to evolve in ways impossible to predict. As the COVID-19 pandemic has taught us, our designed environments must be poised to adapt based on evolving hybrid workstyles and new norms. "The way we started to design these interior spaces pre-pandemic is certainly not how we'll use them post-pandemic," says Radcliffe. "But for us, the design was always about how quickly we can flex these interiors, reconstruct, and adapt them for new ways of working."

We want our buildings to be vibrant for decades to come, even as we face an unknown future. This project reinforced the value of using research to see around those blind corners, applying science-based design drivers to guide our thinking and planning. And it's not just relying on existing data – our research-based method prioritizes exploration and inquiry, turning over every stone to think about how to solve problems in a variety of ways. "This project demonstrates our insistence on innovation," says Mark Golan, VP of real estate investment management. "More than simply tolerating it, there's an outright expectation for innovation that will really push the envelope."

This spirit of radical inquiry informs our approach to future projects in Silicon Valley and further afield. We continue to ask questions around how to make truly sustainable solutions for things like integrated PV and CLT that don't cost more than traditional construction, and are therefore easier for ourselves and others to replicate. We've learned that it's not always about developing new solutions, but often about utilizing existing materials, technologies, and systems in unique ways. It's a mindset of applying creative thinking and collaborative problem-solving to age-old questions of how to construct spaces and places where people – and the environment – can thrive. "We brought together futurists, researchers, and social scientists to create vectors of possible, probable, and desired future states to help sculpt solutions," explains Michelle Kaufmann, director of R+D for the built environment.

Ultimately, these buildings are meant to serve as tools to the people who inhabit them, helping individuals and teams do their best work in the healthiest environments possible, and for decades to come. We see them as living laboratories whose lessons will continue to unfold as users and visitors engage with them over time.

Tracking Performance

We know the effectiveness of our design solutions at Bay View and Charleston East can't be measured on day one, or even on day 100 of the buildings' occupancy. In order to understand how our innovations

perform, we need to measure and document them over time and understand how they track to user satisfaction. That's why we've developed a five-year performance program for the buildings. By gathering post-occupancy information, including occupant surveys as well as direct measurements, we'll gain a deeper understanding of how the building systems in action map to design intent. We're going beyond typical industry standards for this type of documentation, working to quantifiably measure the performance of the space and test whether we achieved our intended outcomes. Even more, during this period of five years, we plan to keep the delivery and operations teams together so we can effectively tune the buildings according to changing needs. That way, the ideas set out in design and realized in construction can evolve in response to real-time user feedback. "Typically, design and construction teams don't get to see how their buildings function, so the learning loop is broken," explains Asim Tahir, director of energy and carbon. "This is a huge gap in knowledge-building we're hoping to fill with the five-year performance program." Documenting and sharing these lessons learned will also help demonstrate the benefits of technologies and building systems used on the projects, both for our partners and for the wider industry.

A phone room allows for small, private meetings to take place adjacent to work areas.

R+D Lab for the Built Environment

When we started rethinking our approach to ground-up buildings in earnest in 2015 – a discussion that ultimately culminated in Bay View and Charleston East – we recognized we needed a new process to realize the audacious goals around sustainability and healthy workplaces. "The typical way of designing buildings just wasn't going to work for Google," recalls Michelle Kaufmann, our director of R+D for the built environment. We needed a dedicated place to prototype and test solutions during the design phase, rather than waiting to mock up solutions during construction, which is when it typically happens. And so our R+D Lab for the Built Environment was born.

New workspaces are piloted at Google's R+D Lab for the Built Environment, allowing varying degrees of privacy, focus, and access to teams.

During the early concept days for Bay View and Charleston East, the team would gather at the R+D Lab, where we would build things as we were talking about them – features like integrated PV panels, exterior shade devices, and mass timber connections. "To deliver on the vision of the project, we couldn't just order readily available products and systems in the market," explains Kaufmann. "We had to try out new products not yet on the market, and test new ways of using existing materials and systems in innovative ways." In the project's early days, the entire design/build team would gather in the R+D space for workshops, where we would construct physical prototypes while sketching, looking at plans and renderings, and considering engineering analyses. We brought team members from all disciplines together, and found huge

value in working from physical prototypes rather than the more typical 2- or 3-D visualizations. It gave us a shared language and basis of understanding that allowed us to move further in collaborations.

Even before the genesis of the R+D Lab, this type of research-based inquiry informed our team culture. Earlier pilot projects at our Silicon Valley campus that were focused on all-electric buildings, 100% outside air buildings, geothermal systems, and PV technology laid the groundwork for Bay View and Charleston East – research topics we continue to pursue today. Now the R+D Lab is a place where we can study, build, and test new building solutions by capitalizing on the scale of projects we're designing. "The innovations developed here can support multiple projects on our campuses," says Kaufmann. "It allows us to make meaningful progress at scale."

Next Iterations

Just as Bay View and Charleston East learned from our decades of tenant improvement projects and accompanying research into building systems, materials, and biophilia, these buildings are already informing our work on new ground-up construction projects and larger districts. As we learn more about how Bay View and Charleston East perform, we can layer in this new knowledge to our designs for future buildings.

At Charleston East, we explored the possibility of designing a mass timber building to tap the regenerative, carbon-sequestering properties of wood. Mass timber is a construction technique utilizing wood compressed together to create columns, beams, walls, floors, and roofs in a way that can reduce embodied carbon by over 80% versus the steel and concrete equivalent. We started with cross-laminated timber (CLT) at Charleston East for the formwork (which we left in as part of the structure, rather than removing it and throwing it away, as is typical). Now the research we performed on that building is informing a new project under construction in Sunnyvale at 1265 Borregas called, fittingly, Mass Timber. Here we designed the 165,000-square-foot building entirely in mass timber for all its structural components.

Nearby, 1212 Bordeaux, designed by Parabola Architecture and completed in 2018, also served as a testing ground for many of the ideas developed at Bay View and Charleston East. Here we tested various strategies

1212 Bordeaux in Sunnyvale, California, incorporated many lessons from Charleston East and Bay View about biophilic design and workplace performance.

Google's Caribbean campus development in Sunnyvale, California, builds on lessons from Charleston East and Bay View and offers sloping green roofs that connect Googlers to the outdoors and each other.

for optimizing elements like daylight, air quality, and acoustics, and advanced research around healthy materials and biophilia. It was also where we piloted efforts toward the integrated design-build process we used on Bay View and Charleston East.

At Caribbean, a planned five-story new building in Sunnyvale, we're continuing our work with BIG to design a workspace that takes biophilia to the next level. At this location, the team spaces face north and spill out to a sloping green roof with outdoor working spaces that are bike-friendly and connect all the way to the ground, meaning someone can bike all the way to their desk on the fifth floor. As we thought about scaling up the building systems from Bay View and Charleston East to our wider districts, we knew we'd have to break down the challenges of sustainable design in different ways. With Caribbean, we're also working on a plan for a central utility plant that will allow multiple buildings to share heating and cooling systems.

As the first teams move into Bay View, our hypotheses around the future workplace will be put to the test. "One of the things I'm most excited about is having many dedicated team collaboration spaces and huddle rooms," says Vidhya Srinivasah, vice president in the Ads engineering organization that will reside in Bay View. "Often, breakthroughs in tough problems or innovative ideas happen in real-time, so having the flexibility to grab a room to chat with teammates – both in person and remote – is a huge benefit to our hybrid team culture."

As we chart a path toward more collaborative ways of working that are equitable for all, it's clear that the buildings themselves can establish an environment where everyone feels like they belong. "I'm hoping the space will genuinely inspire new ways of working together in our new hybrid normal," says Suzanne Pellican, vice president of Ads user experience, whose Mountain View employees will also move into Bay View. "As we lean into the future of work, it will include the interplay between our physical and virtual spaces, and I'm looking forward to seeing how Googlers use the space to connect with their colleagues, no matter where they sit."

Whatever the future holds, we hope these buildings can be a case study toward future innovations to create even more connected environments – sustainable places that benefit people and the planet, for years to come. "Bay View and Charleston East were never meant to be reference points," says Radcliffe. "Rather, they are starting points."

A view of Bay View photographed by Iwan Baan.

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Holmes Fire - Life Safety
Industrial Door Company - Commercial Doors
Integral Group - MEP Engineer
Interface, Inc.
Interior Architects - Interior Architect
International Parking Design - Parking
IRIS-RPS Group - Environmental Consultant
iSEC - Computer Security
JJ Albanese - Concrete Jones Tile and Marble - Flooring
JTS Painting - Commercial Painting
Kingspan - Building Envelope Solutions
Kleinfelder - Geotechnical Consultant
KMD Architects - Architect
Kodiak Roofing - Commercial Roofing
Kone - Elevator Services
KZ Tile Company - Tile
Laura Guido-Clark Design - Design Consultant
Loisos + Ubbelohde - Lighting & Daylighting Consultant
M.C Dean - Security

Malcolm Drilling - Drilling

Mark Stech-Novak Restaurant Consultation & Design - Kitchen & Food Service

Masterpiece Painting - Exterior Painting Services

McLean Bergel - Interior Design

Medcor - Medical Subcontractor

Miller Paneling - Interior Wall Services

Mobile Modular - Modular Building

Montbleau and Associates - Woodwork

Mott Macdonald - Healthy Materials Consultant

Municon - Geotechincal Services

MVP Performance - Coaching Services

NEx Systems - Flooring

OLIN - Landscape Architect

Olson & Co. Steel - Steel Fabricator

Pacific Erectors - Cladding & Facade Services

Pacific Glazing Constractors - Commercial Glass

Pacific Structures Inc. - Concrete

Page & Turnbull - Architectural Services

Partition Specialties Inc. - Interior Specialty Contracting

Penninsulators - Window Treatment

Performance Contracting - Specialty Contracting

Pivot Interiors - Interior Design

Point Energy Innovations - Renewable Energy Engineering Services

Populous - Architectural Services

Power Engineering - Civil Engineering

Preston Pipelines - Utilities Infrastructure

Prototyping - User Experience Design

R.P. Coatings - Paintings & Coatings

REC Solar - Solar Power Services

Red Cloud - First Responder DAS System Designer

Rolling Plains - Fireproofing

Rosendin Electric - Electrical Services

Rowecon Group - Planning & Scheduling Services

RWDI - Wind & Microclimate Consultant

S.J. General Building Maintenance - Janitorial Services

San Francisco Estuary Institute (SFEI) - Ecology Advisor

San Francisco Interiors - Commercial Acoustic Services

Sares Regis Group of Northern California - Development Manager

Scaled Robotics - Digital Surveying

Schuff Steel - Steel Fabricator

SERA Architects - Architect

Service Metal Products - Finish & Trim Services

Sherwood Design Engineers - Water & Wastewater Consultant

Shums Coda Associates - Building Inspection

Sidewalk Labs - Urban Infrastructure

Silicon Valley Glass - Commercial Glass

Silvercreek - Modular Electric Room Subcontractor

Smith-Emery - Building Safety

Southland Industries - MEP Systems

Southwest Steel - Metal Fabrication

Sprig Electric - Electrical Services

STUDIOS Architecture - Interior Architect of Record

Sunbelt - Equipment & Tool

SunStyle - Solar Design Consultant

Superior Tile & Stone - Stone Supplier

Synergi - Glass Guardrail Subcontractor

TEECOM - Telecommunication

Terrapin - Biophilia Consultant

Therma - Mechanical Solutions

Thornton Tomasetti - Structural Engineer

Trim Tech - Commercial Doors

TriMark - Kitchen Equipment Subcontractor

Turner & Townsend - Project Controls and Accountant

Unified Works - Team Training

Urate & Sons Concrete - Concrete

Valhalla Builders - Industrial Construction

Vantis - Construction Planning Services

Walters & Wolf - Interior Services

Weidner - Signage and Wayfinding

Welker Bros - Flooring

West Coast Fire Stopping - Firestopping

Western States - Fire Protection

Whiting-Turner - General Contractor

William White - Parking & Access Equipment Subcontractor

WRA - Environmental Consultant

XSPlaforms - Safety Equipment

Consultants and Project Partners

CHARLESTON EAST

3D-identity (workplaceelements) - Artwork and Storytelling Designer

A. Zahner Co. - Canopy Bullnoses & Nodes Designer

ACCO - HVAC Subcontractor

Acousthetics - Acoustics Consultant

Adamson Associates Inc. - Architect of Record

AddLife - Interior Plant Design, Procurement, and Installation

Ad-In Inc. - Acoustical Ceiling Subcontractor

Advanced Systems Group (ASG) - AV Integrator

Aidlin Darling Design - Retail Architect

Alcal Specialty Contracting - Canopy Waterproofing Subcontractor

Allana Buick & Bers, Inc. (ABBAE) - Design/Construction Monitoring CETCO waterproofing membrane

Alliance - Canopy Roofing Design

Anning-Johnson - Metal Decking Subcontractor

Applied Wayfinding - Wayfinding Consultant

Arthur Drooker - Photographer

Arup - Structural, MEP, and Acoustic Engineers of Record

B.T. Mancini RAF (BTM) - HS RAF/Resilient Base

B.T. Mancini Flooring (BTM) - Carpet and Resilient Flooring

Baker Corp - Site Groundwater Treatment

Benson Global - Canopy Exterior Glazing

Berkel Company - Augercast Piles

Bjarke Ingels Group (BIG) - Co-Lead Design Architect

Blue Oak - Photovoltaic Installer

Bothman - Site Concrete Subcontractor

Brand/Safway

BSI Services & Solutions (West) Inc. - Field Construction Safety

Burning Man Group - Public Artwork Curator

California Drywall - C&S Metal Framing and Drywall/Sprayon FP

Cal Coast Telecom - Site Access/Badging

CBRE - Initial Field Management, Space Planning, Facilities Management

CMC Rebar - Concrete Reinforcement Subcontractor

Central Concrete - Concrete Material Subcontractor

Code Consultants, Inc. (CCI) - Code Consultant

Complete Millwork Service, Inc. (CMSI) - TI and White Box Millwork Subcontractor

Consolidated Engineering Laboratories (CEL) - Testing and Inspections

Cool Shadow

Condon Johnson

Cornerstone - CMU Subcontractor

Corporate Signs - Signage Subcontractor

CS Caulkins Co., Inc.

Cummings - Previous Estimating Team

Cupertino Electric, Inc. (CEI) - Electrical Subcontractor

D.W. Nicholson Corp. - Rolling Doors, Loading Dock, VRC

Deeplocal - Artwork and Exhibit Designer

Dees Hennessey

Della Maggiore Tile, Inc. - Tile Contractor

DeSilva Gates - Site Grading and Paving Subcontractor

Devcon Construction Inc. (DCI) - C&S and TI General Contractor

Diamond Bay Fence - Temporary Fencing

Dolan Concrete - Structural Concrete

Door Hardware Consultants - Door Hardware

DR Johnson - CLT Fabrication

Edgett Williams Consulting Group, Inc. - Vertical transportation consultant

EKI Environment & Water, Inc. - Vapor Mitigation Barrier Design/SSD System Design

Elevate Environmental Consultants Inc. - Environmental Consultant

Electrosonic (ESI) - AV Designer

Enovity - Commissioning Consultant

Evans Brothers - Structural Excavation and Backfill

Fisher Marantz Stone (FMS) - Lighting Consultant

Floor Seal - Polished Concrete Subcontractor

Gayle - HS Structural Steel

Glazier - Steel Subcontractor

GoodFellow Bro - AC Paving

Griggs Resource Group - Auditing Team

H.T. Harvey & Associates

Hargreaves Jones Landscape Architecture - Landscape Designer

Hathaway Dinwiddie Construction Company (HDCC) - Initial C&S General Contractor

Hatchmott

Heatherwick Studio - Co-Lead Design Architect

Hirschfeld

HLW - Interiors Architect and Interior Designer

Integral Group - LEED Consultants

Iris

Jak W - Accessories Designer, Procurement, and Installation

Jerry Thompson & Sons Painting

Jones Lang Lasalle (JLL)

Joseph J Albanese - Concrete Subcontractor

Kaz & Associates - Stormwater Compliance Consultants

KBM Hogue - Furniture Vendor

Kier & Wright Civil Engineers & Surveyors, Inc. - Surveyor

Kingspan - Thermal Insulated Panel Supplier

Kleinfelder - Geotechnical Engineer

KONE - Elevator Consultant

Lightswitch - Lighting Consultant

LMG - AV Integrator

Loisos + Ubbelohde - Lighting and Daylighting Consultant

Lombardia Consulting - Schedule Consultant

M.C. Dean - Security Consultants

Macro Zeccin Enterprises LLC - Photographer

Magnum Drywall - Drywall Subcontractor

Mark Stech-Novak RCD (MSN) - Food Equipment Designer

Maxim - Crane Rental Company

McClone Construction - Canopy and HS Formwork

Medcor

Mesh Consultants

Minton Doors - Doors, Frames, and Hardware Subcontractor

Mission Bell - Millwork and Studio Partition Subcontractor

Miyamoto International Inc. - Structural Engineering Consultant

Mott MacDonald (MM) - Civil Engineer

MVP Performance Institute LLC - Executive coaching and team development

Nicholas L Sica - Development Management Services

Oculus Light Studio - Lighting Consultant

OpenSpace AI

Pan Pacific Mechanical - C&S Plumbing Subcontractor

Performance Contracting Inc.

PDC Group

Peninsulators

Pie Consulting & Engineering - Roofing and Building Envelope Consultant

Pine Pacific Services (Multivista) - Lazer Scanning and Complete Documentation Services

Preston Pipelines - Site Utilities

Project Management Advisors, Inc. (PMA) - Development and Project Management Team

Quality Erectors - Architectural Paneling and Custom Metal Fabricators

RCD

RDH

Recology - Waste Management

Red Cloud Inc.

Rolling Plains - C&S Fireproofing

Rosendin Electric - Joint Trench and Off-site Lighting

RWDI

Service By Medallion - Site Cleaning and Janitorial Services

Service Metal Products - Toilet Partitions and Accessories

Service West - Furniture Installer

Sherwood Design Engineers - Water Reuse Systems

Shooter & Butts - Paving/Landscape Subcontractor

Silicon Valley Glass - Glazing Subcontractor

Simpson Gumpertz & Heger - Canopy Waterproofing Consultant

Skycatch - Aerial Data Capture (Drone Supplier)

SME Steel Contractors - Canopy Structural Steel Subcontractor

Solarbuyer LLC - Photovoltaic Panel Quality Assessment

Southwest Steel of California - Steel Subcontractor

Sprig Electric - Solar Panel Subcontractor

Stafford Design Group

Stonhard - TI Epoxy Subcontractor

Sunbelt Controls - Design Assist Engineering

Sunstyle: Ostermundigen - Photovoltaic Roofing Shingles Supplier

T.S. Krumholz, Inc. - Initial Project Management Team

Teecom - Telecommunications Consultant

Therma LLC - Flashing and Sheetmetal Contractor

Tractel Ltd.

Transbay Fire - C&S Fire Protection Subcontractor

Turner & Townsend - Project Controls

Vizion Utility Partners - PG&E Design Consultant

Walters & Wolf Interiors - TI Doors, Frames, and Hardware Subcontractor

Walters & Wolf Glass - TI Glass Subcontractor

William McDonough - Building Materials Consultant

WeSTco Ironworks - Metal Stairs and Rails

XL Construction - Prototypes

Book Credits

Civilization (Gabriel Stromberg, Michael Ellsworth, Corey Gutch, Michael Evans, Trish Chua, Raya Leary, Sal Hill) - Concept and Design

Lauren Gallow - Writer

Prose Media - Copyeditor

Hemlock Printers - Printer

Joseph Vandenorth - Marketing Lead, Google

Kirsten Ritschel - Image Coordination, Google

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