Building with Ceramics

Terra Cotta Architecture: From Clay to Kiln

contemporary and timeless

by Michelle LaFoe, AIA

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PHOTOGRAPHY SINZIANA VELICESCU; OFFICE 52 ARCHITECTURE, DESIGN ARCHITECT.; TERRA COTTA SHILDAN GROUP | MOEDING.

Architectural ceramics includes terra cotta, one of the oldest manufactured building materials. With a knowledge of ceramics production technology early in the design process, we looked beyond the standard terra cotta glazing options offered by the industry for an affordable solution that achieved a rich visual quality that played with the region's unique lighting and colors.

The kiln firing process is one of the most important manufacturing stages in architectural ceramics because the clay elements undergo a transformation in their chemical and physical properties.

This essay is based on our architecture and interest in ceramic materials and glazing from a contemporary perspective. We looked at the potential of ceramics by reviewing its history, revealing unique applications compatible with current production methods. An understanding of ceramic fabrication processes broadened our intent to be true to the material. Hands-on experimentation revealed its essence. We considered the importance of form, color, and light for a poetic solution. This integrated art into the fabric of the building through craft, science, and modern technology for a high-performance prefabricated ceramic façade assembly, the most affordable terra cotta system used today for buildings.

Design Process

When our studio commences a project, material choices are crucial in expressing the architectural idea and realization of form. By thinking three-dimensionally in cross-section we are also thinking about the material details that support the design vision for a fully resolved building. While looking at place and context we think about how the program - or what's in the building - could be organized and explore viable spatial options.

Hands-on experience provides a fuller understanding of each material employed. We look at the evolution of a material's development, its unique capabilities, and innovative fabrication processes that define how a material is created, formed, and finished. Looking at the art world, construction practices, and other disciplines provides a greater understanding of a material and its full potential, both expressive and industrial. In the studio we explore much like a sculptor does to intuitively test the architectural idea in terms of volumetric expression and surface finish.

PHOTOGRAPHY SINZIANA VELICESCU.

Tykeson Hall (top) employs terra cotta with open-joints (bottom right) and five color glazes on a neutral clay body. We looked at similar glazing methods like Mayan tetrapod jar production, 200 B.C.–A.D. 1, Izalco Usulután ceramic innovation with orange on a cream-colored clay for a two-color technique with a burnished surface.

PHOTOGRAPHY TOP SINZIANA VELICESCU; BOTTOM LEFT THE MET OPEN SOURCE:; PHOTOGRAPHY BOTTOM RIGHT I. CAMPBELL

Architectural ceramics features a rich history of inspiring examples and endless potential. We looked to the future by understanding the past from Mayan, Babylonian, Greek and Etruscan ceramics and terra cotta fabrication and finishing processes to della Robbia, Gaudi, Sullivan, and modern production technology for architectural ceramic assemblies and contemporary facade design.

Since materials exhibit different aesthetic qualities depending on their characteristics, we look at them outside on site to see how they interact with the environment in the intended location. It is important to work closely with fabricators on innovative building applications to define the technical and aesthetic parameters of the systems to be applied to the building.

This has been our approach for most projects, including the design and construction of the Willie and Don Tykeson Hall at the University of Oregon. The building façade features a unique blend of locally-sourced, hand-laid brick and a high-performance architectural terra cotta rain screen system constructed of prefabricated, custom-glazed extruded panels.

Architectural Ceramics

Clay is a timeless material, a classical medium described by Pliny, or as the modern artist Henry Varnum Poor stated, from "mud into immortality." Etymologically the word ceramics signifies non-metallic raw materials and firing operations. The process of making ceramics involves firing clay in a kiln whereby it is transformed into an insoluble material.

Ceramic façade products made of clay include face brick and terra cotta, two of the oldest manufactured architectural ceramic building products for large-scale assemblies. Terra cotta is a Latin term for "baked or cooked earth," and it is traditionally made from moist clays formed in molds and then fired at a very high temperature in a kiln to produce building materials, tiles, and large statuary. One of terra cotta's distinct characteristics is its plasticity thanks to a clay body with a fine texture that can be formed into various shapes and finishing capabilities for ornamental and façade cladding for buildings. Façade tiles are often made in the form of hollow blocks with internal supports (or webbing) that allows it to be both light and strong.

Terra cotta's light weight, ease of production, durability, and low maintenance have typically offered greater flexibility in design compared with other more expensive building materials such as stone. With proper installation terra cotta withstands severe climates both for freeze-thaw and UV resistance. It is non-combustible, has high compressive strength, and does not off-gas. Terra cotta is also good from an energy and CO2 cost standpoint. No CO2 is generated from the raw material itself, and it requires the least amount of energy and generates the least CO2 in production compared to other building materials such as cement, steel, plastics and aluminum. Heat, or thermal energy, is stored and released in the ceramic material itself.

The terra cotta production process includes batching, souring, forming/sculpting, drying, firing, glazing, sizing, and fitting. Fabricator clay recipes typically source several clays that are mixed for thorough blending and then aged in a souring bin so the plasticity of the clay reaches a molecular level appropriate for through-body forming. The completed forms are loaded into driers for water content removal and to ensure a proper drying rate to prevent cracking. Drying cycles can last several days. The length of time varies according to type of piece, the form, size and quantity in the drier, and the method of drying. Then the pieces are fired and glazed.

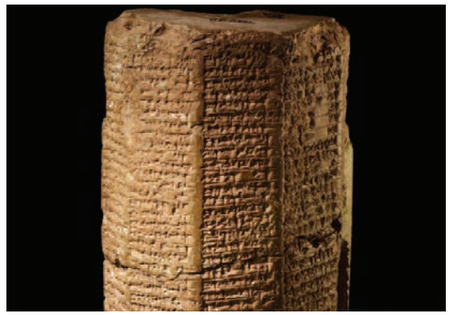
Terra cotta is characteristically different from brick in its clay composition and higher firing temperature over a number of days in the kiln. The ceramic material itself has a glass phase that fuses and bonds

"FROM MUD INTO IMMORTALITY," TITLE OF CERAMIC ARTIST HENRY VARNUM POOR'S FAMOUS 1987 BOOK.

Understanding production processes: this page clockwise from upper left: Glazed bricks, Achaemenid Period, ca. 559–331 BCE, Iran (image MET public domain); Baked clay tablets and sculpture, mid-4th millennium BC to 1st c. AD, Yale University Babylonian Collection, Yale Peabody Museum, Sterling Memorial Library, New Haven, CT.; Lead-tin glazed earthenware vault, Luca della Robbia, San Miniato del Monte, Cappella del Cardinale del Portogallo, 1461, Florence, Italy (image LaFoe 1995); Cai Guo-Qiang's Murmuration: The Transient Landscape, 10,000 hand-formed porcelain Birds (National Gallery of Victoria public domain); Life-size terra cotta figures, Qin Dynasty, 221-207 BCE, Qin Shihuang mausoleum site, Xi'an, China (National Gallery of Victoria public domain); Blue-glazed panel, (Yale Babylonian Collection); Terra cotta decagonal Babylonian prism with script (The British Museum public domain); Terra cotta tiles, Shyamrai Temple Bishnupur, India, 1626-1656 AD. (image Creative Commons); Page 8 upper left: Furstenzug-Dresden's Procession of the Princes 101 meter long wall mural, German Meissen porcelain tiles,1904-1907 replaced 1871 original (image LaFoe, 1995); upper right: Glazed terra cotta striding lion, Babylonian, 604-562 BCE (RISD, public domain (CC0 1.0).









everything together and determines the microstructure and densification during firing, which compacts and strengthens the clay body. This phase includes sintering and vitrification, whereby the clay becomes a ceramic material.

The kiln used is of utmost importance, and in many cases are custom-made for building project orders. Accurate processing, temperature distribution, and temperature uniformity are desired conditions for sintering in the thermal process. As with glass production, kiln dimensionality determines the size of ceramic pieces that can be produced with both industrial and art furnaces. Contemporary terra cotta façade manufacturers typically use larger industrial-sized kilns. For an excellent exhibition of ceramic art kilns, see photographer Brian Oglesbee's Kilns of Alfred: Transactions with Fire at the Alfred Ceramic Art Museum in 2019.

Forming Processes

Ceramic forming processes include manual or hand-forming, dry pressing, plastic pressing, slip casting, and extrusion. Prior foundry experience and sculpture work while at the School of the Art Institute of Chicago early in my career and hands-on experimentation with materials contributed to knowledge of ceramic forming processes. In addition, my design partner's previous work with artists, manufacturers, and innovative fabrication methods yielded invaluable information and creative results as well. This included his work on the Architectural Enhancement Program for the New North Terminal at Reagan Washington National Airport, a project that included floor mosaics, curtain wall art glass installations, and porcelain balustrade panels. He also grew up in Alfred, New York and studied at Alfred University, home of the re-known New York State College of Ceramics and the 1892 Celadon Terra Cotta Building.

Hand Forming

With hand forming, molds are used primarily in the hand-pressed process for sculptural pieces but also for RAM presses and slip-casting. A number of materials are used to craft the model, such as rubber, plaster, Plasticine, metal, and wood. The molds are the negative of the finished piece and are filled by hand with malleable clay. Because clay is formed wet but goes through a drying and then firing process, the piece must take into account shrinkage. If plaster is used, it dehydrates the clay and allows the piece to hold its form when released from the mold. RAM-pressing can produce large objects and low shrinkage, which is good for multiple similar pieces. A RAM press is a hydraulic press that was once used for forming the clay in the porcelain industry. Slip casting with a mold is labor intensive, requires great skill, and has higher shrinkage if salt water is used.

An example of the hand-forming process is Qin Shi Huangdi's life-size terra cotta horses, people, warriors, birds and other entities interred in Northwest China approximately 2,200 years ago. The work commenced in 246 B.C. Each warrior is made from seven main parts that were hand-crafted of local clay, coiled in layers then pressed into molds, fired in a kiln and then painted with bright pigments (image page 7).

Other examples hark from the Yale Babylonian Collection, which I visited several times when I worked in New Haven, Connecticut in the 1990's. The collection was recently highlighted in a 2019 exhibition, *Ancient Mesopotamia Speaks: Highlights from the Yale Babylonian Collection*, featuring 150 artifacts

such as baked clay tablets with poems, 4,000 year old original recipes, and translations dating from the mid-4th millennium BC to the 1st century AD. Babylon clay cuneiform tablets also reside in the Metropolitan Museum collection, and The British Museum has a gorgeous late Babylonian baked decagonal clay prism with cuneiform Babylonian script with a production date of 674 BC to 672 BC (image page 7).

Our studio was also familiar with the glazed-brick fabrication of the Ishtar Gate and roadway north of the gate, lined with glazed terra cotta figures of striding lions completed in 604-562 BC (image page 8). Because stone is rare in southern Mesopotamia, molded glazed bricks were used for building, and Babylon became a place of brilliant color. The beginning chapters of Helen Gardner's elaborately illustrated *Art Through the Ages* are dedicated to clay-based art in Egypt, the Tigris-Euphrates Valley and Persia (starting in about 4,000-1,925 BC) and Greece. This book was part of a vast collection of art and architecture publications I inherited from my grandfather and also included the exquisitely illustrated *Glazed Tiles and Trimmers* published by the Associated Tile Manufacturers in Beaver Falls, Pennsylvania in 1921 (copy No. 6201). A 2017 exhibition curated by Pedro Azara, *Brick by Brick: Ceramics Applied to Architecture*, also features an excellent array of hand and machine produced ceramics.

Extrusion

The extrusion method pushes material through a die with a uniform cross-section so that a large number of pieces can be made with efficiency and unity of form with a hollowed-core unit, most useful for the production of linear directional profiles that require many units. It typically utilizes CNC machine tooled steel extrusion dies. The dies are engineered for the size and color of each panel profile. The clay must be plastic thus water to clay ratio is important for a successful form since a tremendous amount of compression takes place within the extruder. Different clay mixtures also have different shrink rates when dried thus changes to body color impact die size.

Heat treatment includes kiln firing with a peak temperature dictated by material properties. One of the main differences between various types of clay is the temperature at which they become ceramic.

Different types of clay can cope with different levels of heat. Big pieces of terra cotta firing can take several days to be vitrified, and consistent heating of the clay is crucial. If the outside heats too quickly versus the inside, you can have isotropic issues. Isotropic means that the material's properties are identical in different directions. The ideal is to avoid any open porosity for a durable body that can endure seasonal changes. The profiles are extruded into lengths longer than the finished size specified to account for shrinkage during the drying and firing process. After rough cutting, either with a wire or diamond-edged wet saws, finishes are applied. This process is standard in architectural terra cotta manufacturing today.

Due to economics and project schedules, most contemporary building facades are made with off-the-shelf extrusion systems, yet there is opportunity to interpret these in new ways with customization of system components and glazing for facades that are special to the place with uniqueness of function and artistic rendering of the building. A multitude of materials can be employed in rainscreen systems, including wood, metal and masonry. Terra cotta however offers a relatively affordable way to achieve a durable finish with superior insulation values. Recent exploration of digital tools including parametric modelling, 3D printing, and CNC 5-axis routers and wire cutters from pre-design through prototype development have culminated in ground-breaking ceramic experimentation and manufacturing possibilities.

Finishing Process

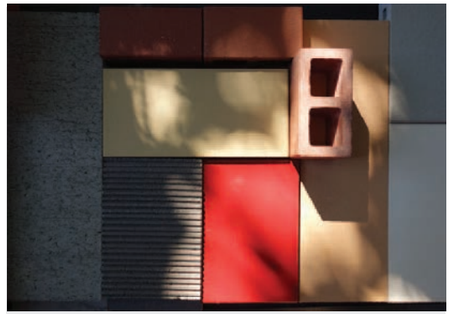
There are two finishing options for extruded forms: through-body and glazing. Through-body color means that the color of the final piece is achieved through a combination of mixing clays and/or including minerals or stains to create a permanent color throughout the clay mixture due to permanent bonds formed at high temperatures. Through-body ceramic extrusions tend to be more expensive because the manufacturer has to make a different die for each through-body clay color because each color mixture has a different density. This is why our design for Tykeson Hall's terra cotta façade employed a single neutral-colored clay, thus requiring only one die, and desired aesthetics with five custom glazes to meet budgetary goals.

PHOTOGRAPHY SINZIANA VELICESCU.

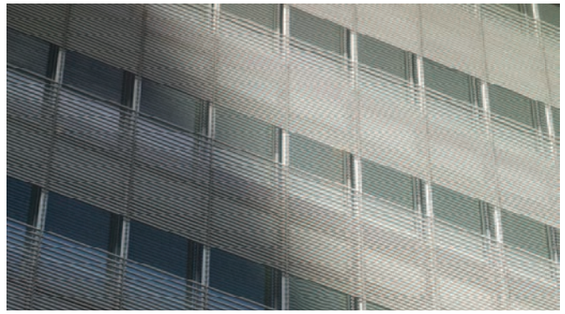
Our studio looked at the evolution of innovation in terra cotta including clay-body forms, manufacturing and finishing options, and sustainability attributes for buildings. Clockwise spiral from upper left: Terra cotta detail, Adler & Sullivan's Chicago 1892 M.A. Meyer Lofts; Modern extruded terra cotta (image courtesy Shildan Group); New York Times Building, Renzo Piano, 2003-2007; Louis Sullivan's National Farmers Bank Minnesota 1906-08 (detail of image by Cervin Robinson); Etruscan terra cotta sarcophagus Cerveteri c.520 BC Museo Nazionale di Villa Giulia, Rome, Italy (creative commons); Mayan Cylindrical Vessel 1st-2nd c.AD (MET open source); Peterson Tegl platinum-glazed ceramic tile arrangement Olafur Eliasson 2006 (image Arquitecturas Ceramicas); Kato Yasukage's Shino feldspar-glazed stoneware 2006 with 17th c. glaze recipe; Marquette Building Chicago, Holabird & Roche, terra cotta cladding,1895 (creative commons); SHoP's Wave/Cave pavilion Milan (Arquitecturas Ceramicas); Joan Miro, *Chicago*, 1981; Glazed vase, Hiroshi Nakamura, Hokkaido, Japan; Museum Brandhorst, Sauerbruch Hutton (Falbisoner CC 3.0, enlarged detail); Portuguese Azulejos; Cass Gilbert, Woolworth Building, 1913 (Michael Daddino CC 2.0) in *Smarthistory*, Dr. Margaret Herman 2015; Modern extrusion forms.





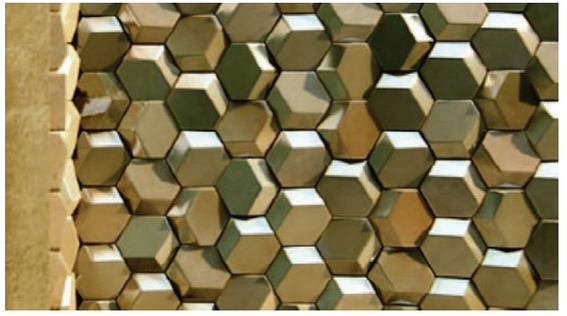



PHOTOGRAPHY MICHELLE LAFOE UNLESS NOTED OTHERWISE IN SIDE TEXT.



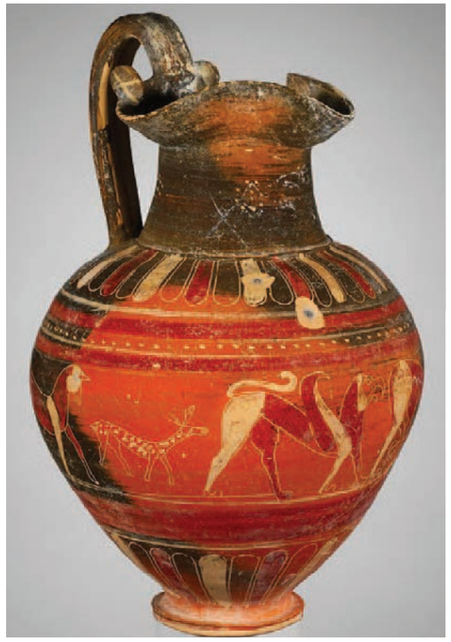




PHOTOGRAPHY MICHELLE LAFOE UNLESS NOTED OTHERWISE IN SIDE TEXT.

We also looked at glazing and finishing processes of hand-held ceramics, statuary, and large scale urban interventions and their translation into industrial productions for modern glazing for buildings. Clockwise from upper left this page: terracotta bust, Louise Brongniart, c. 1910 (Widener Collecion, National Gallery of Art, public domain); Terracotta trefoil oinochoe (jug) ca. 600–550 BC, Etruscan (The MET public domain); Extruded terra cotta with custom glazing (image courtesy Shildan Group); Holland House detail, London, Berlage Hendrick Petrus in collaboration with Royal Delft, 1916 (Photo Gillian Darley, 2019, bdonline.co.uk), I visited the Holland House while a Fulbright Scholar. Clockwise from upper left next page: Terra cotta detail, Urbana, IL; Glazed polychromy brick with guilloche design ca. 9th c. BC, Assyrian, (The MET open source); Holland House (image Charles Saumarez Smith, https://charlessaumarezsmith.com/2017/06/15/holland-house/comment-page-1/); Lekythos, Athens, Greece 440 BC white-ground technique terra cotta; Iridescent glazed terra cotta, MAD NYC, Allied Works with Royal Tichelaar Makkum and Christine Jetten glaze design, 2008; Terra cotta panel, Rice University Houston, Liza and William McVey, installed 1957; Modern slipcast and glazed extruded terra cotta cladding; Guri Amir, Samarkand Uzbekistan, azure fluted dome, 15th c. (Image Loic Brohard).



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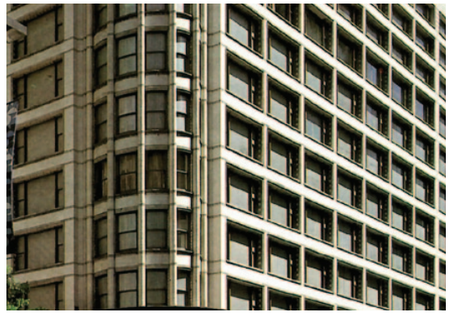
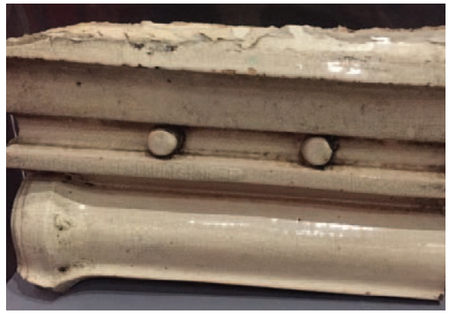
Most contemporary building projects have modest budgets and tight schedules that do not accommodate extensive materials R&D. For Tykeson Hall's high-peformance facade with terra cotta cladding, our design focuses on innovative prefabrication and extruded components with a unique finish for a technically superior and aesthetically beautiful solution that could be fabricated in a timely manner. We experimented with applicable finishing options early in our design process while looking at current and past trends in ceramics technology and high quality glazed ceramics. American terra cotta examples clockwise from upper left: Celadon Terra Cotta House in Alfred, New York, where Campbell grew up; Glazed green ceramic detail downtown Chicago;Glazed terra cotta fragment from D.H. Burnham and Co.'s Reliance Building Chicago, 1895; Detail of Adler & Sullivan's Guaranty Building in Buffalo, New York constructed 1894-96 (detail of image by Cervin Robinson, in *Louis Sullivan, The Function of Ornament,* Chicago Historical Society); Terra cotta detail design Louis Sullivan, Chicago, Illinois; Terra cotta fragment of Adler & Sullivan's M.A. Meyer Lofts in Chicago constructed 1892-93, demolished 1968; Louis Sullivan, Carson Pirie Scott Department Store Chicago 1899, 1903-04 (detail of image by Cervin Robinson).





PHOTOGRAPHY MICHELLE LAFOE UNLESS NOTED OTHERWISE IN LEFT SIDE TEXT.

Architectural glazing includes color, variegation, opacity and finish. There are multiple types of variegation processes that produce astounding glaze results, such as floating, luster, rivulet, crackle and tea dust. Glaze opacity is transparent, semi-transparent, or opaque. Glaze finishes are available in matte, semi-matte, satin, semi-gloss, and gloss. Glaze is visual and tactile, not structural, and it is kiln-fused to the terra cotta piece. Glaze finishes can be one coat of a single recipe or involve three of four different recipes layered in coats. Terra cotta texture finishes include raked, stippled, wire-struck, grooved and dimpled, among others. Installation methods for architectural terra cotta cladding systems have evolved along with innovations in both commerce and the construction industry. Architectural terra cotta rainscreen facades are composed of terracotta panels hung onto an aluminum support, and the clay tile panel system does not require grout or sealants such as silicone like precast concrete panels do.

American Terra Cotta Manufacturers

"A complete history of the use of clay as a constructive or decorative material in architecture would be analogous to that of civilization," stated Walter Geer in 1891, President of New York Architectural Terra Cotta Company from 1896-1919, according to the Illinois-based National Building Arts Conservatory and Building Artifacts Collection.

Terra cotta production in America has a rich history that parallels innovation in building construction. The Avery Architectural and Fine Arts Library at Columbia University states that there were forty-eight major terra cotta manufacturers operating in the late 19th and early 20th century in America, including the New York Architectural Terra Cotta Company in Long Island Queens, New York from 1886 to 1932. It was the only one that operated its plant in New York City and supplied architectural terra cotta for projects throughout the United States and Canada for over 2,000 buildings. Only a small part of the factory exists today, yet its vast influence can be seen throughout New York City and its boroughs with buildings designed by architects such as Cass Gilbert and Carrère & Hastings.

In 1907, the Standard Terra Cotta Company merged with the Atlantic Terra Cotta Company, and Standard's Perth Amboy factory was instrumental in the production of terra cotta for the Woolworth Building due to its proximity to Manhattan. According to the Chipstone Foundation, Perth Amboy in New Jersey also had a lucrative business producing exquisitely crafted architectural terra cotta grave markers in the area. During the late 1800's and early 1900's in Illinois, Crystal Lake was re-known for the manufacture of architectural terra cotta and TECO pottery at the American Terra Cotta & Ceramic Co. factory. Louis H. Sullivan worked there with their modeler Kristian Schneider, and they developed his signature ornamental design for architectural terra cotta.

"Until 1930, the fifty-two-story terra cotta Woolworth Building was the world's tallest building. However, the rapidly increasing size of skyscrapers brought an end to the use of terra cotta as a cladding material for the structure's entire exterior surface," according to *studiopotter.org*. Today there are only a handful of major architectural terra cotta manufacturers for building facades. This includes Shildan Group, NBK, Boston Valley Terra Cotta, and Gladding McBean.

Terra Cotta in Oregon

Portland and Eugene, Oregon had an equally impressive concentration of buildings faced or decorated with glazed terra cotta. A large amount of the terra cotta employed in Portland came from Gladding McBean & Co. based in Lincoln, California, which produced architectural terra cotta for Portland as early as 1882. Stock pieces could be ordered, but most of Portland's terra cotta was custom-made. Examples can be found in the *Glazed Terra Cotta Historic District* publication and in the book, *Last of the Handmade Buildings: Glazed Terra Cotta in Downtown Portland,* by Virginia Guest Ferriday. Terra cotta use in Oregon paralleled that in Chicago, particularly after the 1893 World's Columbian Exposition. Daniel H. Burnham designed Chicago's iconic Reliance Building with glazed white terra cotta, and it opened in 1895, the same year William Holabird & Martin Roche completed the Marquette Building of steel frame with terra cotta cladding to fireproof the building.

Tykeson Hall Façade Design

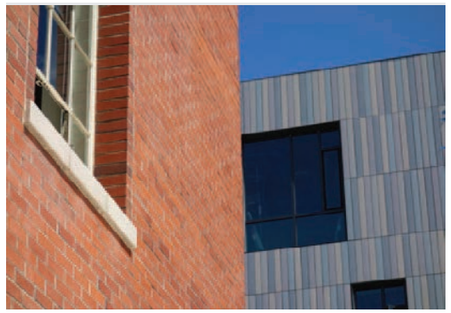
One of the most notable features of the recently completed Tykeson Hall building at the University of Oregon is its custom brick and terra cotta façade. At the beginning of the project, our studio introduced the

One of terra cotta's distinct characteristics is its plasticity thanks to a clay body with a fine texture that can be formed into various shapes and finishing capabilities. Our studio focused on the materiality of architectural ceramics including performance contributions, forming processes, design details and glazing. We customized a readily available prefabricated ceramic component to work alongside the custom brick pattern within tight schedules and budgets. Our studio modelled all 77,000 bricks and 3,100 terra cotta pieces in BIM (Building Information Modelling) while working closely with the brick and terra cotta fabricators to define system technical and aesthetic parameters. Each terra cotta panel was individually numbered on the back in accordance with our design development drawings for efficient installation to ensure no one color repeated next to itself within the system. Images clockwise top left this page: Full scale terra cotta physical models, OFFICE 52; Tykeson Hall facade detail; Chapman Hall terra cotta, University of Oregon, Ellis F. Lawrence, late 1930s; Tykeson terra cotta rainscreen installation; Tykeson terra cotta with Champman Hall (foreground); Tykeson glazed terra cotta rainscreen detail; Through-body extruded terra cotta forms, more costly for the color field aesthetic desired; Chapman Hall terra cotta.

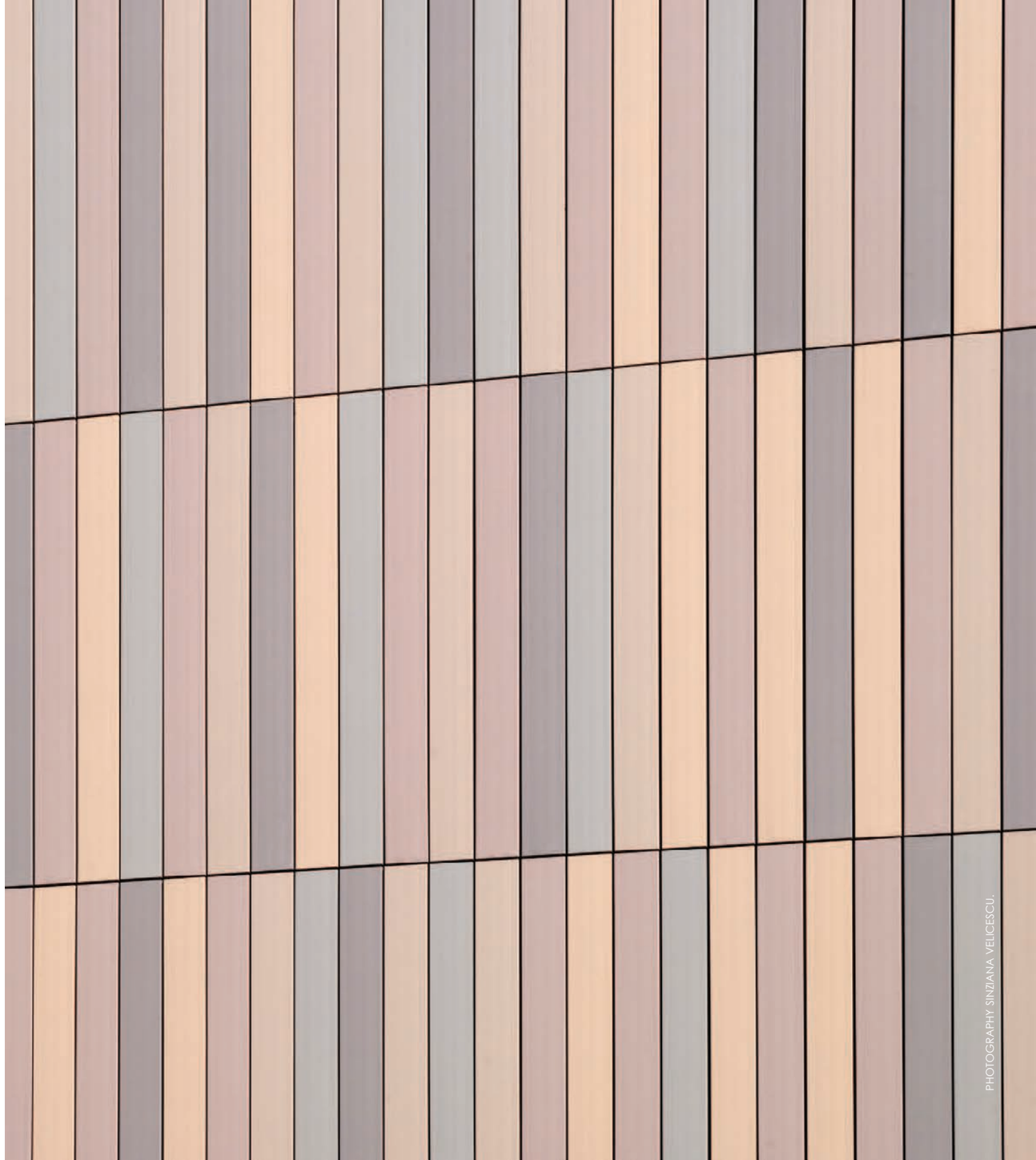






PHOTOGRAPHY THIS PAGE MICHELLE LAFOE; TOP LEFT OFFICE 52 ARCHITECTURE STUDIO; TOP RIGHT SINZIANA VELICESCU.



PHOTOGRAPHY SINZIANA VELICESCU.

PHOTOGRAPHY TOP AND LEFT SINZIANA VELICESCU; RIGHT CHRISTIAN COLUMBRES.

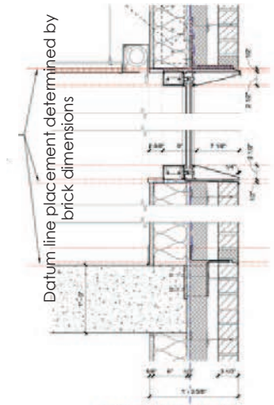
idea of wrapping the main part of Tykeson Hall with terra cotta, a material prized for its craft heritage and tactile qualities yet now produced with advanced high-tech façade engineering and innovative digital capabilities, a metaphor for the innovative spatial program we designed within that part of the building. We encouraged the use of architectural terra cotta on the project based on the fact that the University of Oregon campus features a rich history of architectural ceramics dating to the late nineteenth and early twentieth century. Examples include Johnson Hall (completed in 1914-1915) by architect William Knighton as well as Chapman Hall and Anstett Hall by architect Ellis Lawrence.

Our studio embarked upon a visual survey of historic terra cotta and brick on campus and discussed modern ceramic extrusion options with current terra cotta manufacturers. We researched the materiality of architectural ceramics including performance contributions, forming processes, and glazing options for a contextually appropriate and contemporary solution. We did this early in the design process while working with the client to figure out volumetric placement of the innovative program for the building.

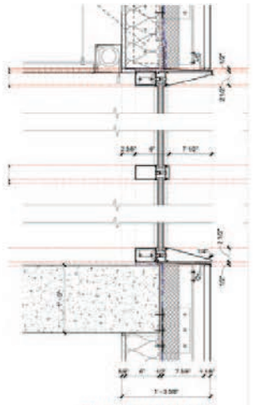
Weaving Systems

By employing both brick and terra cotta in our design and tying the two systems together through proportion and rigorous detailing, the materials are expressive aesthetically, contextually, and programmatically with a rich array of locally-inspired color. For the terra cotta, we transformed a kit-of-parts engineered façade system and designed six-inch wide, vertically-oriented panels with two primary lengths for ease of construction, affordability, aesthetics and regional seismic requirements. We laid everything out on a one-foot module and worked out all corner and return details. The space or void between panels is equally important, and our design for the open-joint terra cotta rainscreen system includes a 3/8" gap between each terra cotta panel, as well as in conditions where the panels meet doors, window sills, heads and jambs.

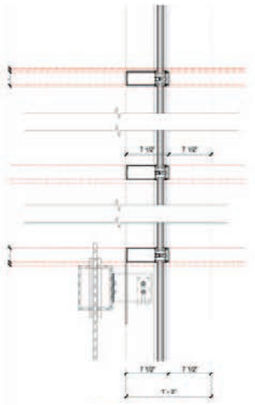
By designing in section and model, we resolved all relationships of the interior systems with the exterior module, an example being the wooden ceiling alignment with exterior window conditions. Our studio



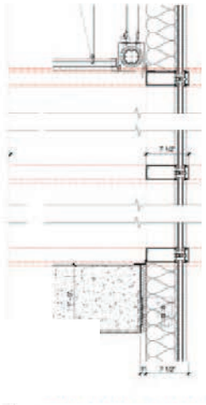
Typical opening in brick



Typical opening in terra cotta



Typical capped curtain wall at open stairs



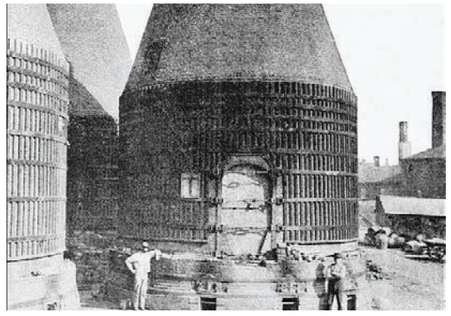
Typical capped curtain wall at the Commons

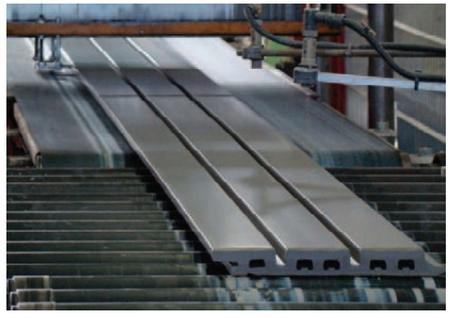
The design combines prefabrication technology with a regional craft aesthetic for a building that features a high-performance architectural terra cotta rain screen system and a unique blend of locally-sourced, hand-laid brick that we weaved together with a common language of fenestration detailing and datum lines. Attention to the terra cotta glaze design amplified artistic expression.

PHOTOGRAPHY BOTTOM LEFT AND RIGHT AND MIDDLE BY MICHELLE LAFOE; DESIGN DEVELOPMENT DRAWINGS OFFICE 52 ARCHITECTURE (TOP).

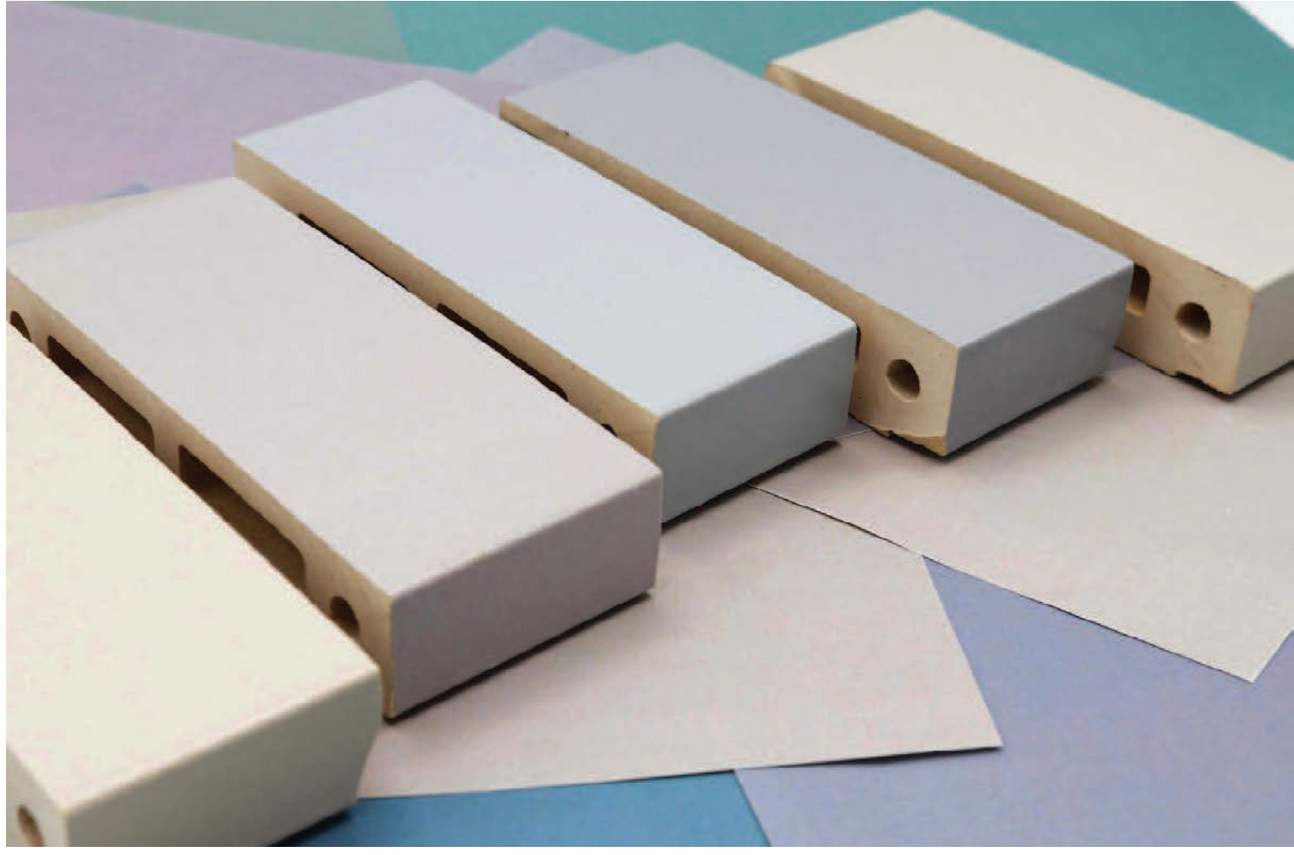
PHOTOGRAPHY M. LAFOE

We looked at the artistic potential of ceramic glazes for industrial production early in the design process and worked closely with the fabricator so the glazing as a material could reach its full potential for the building. The design process included a back and forth collaboration with Shildan Group/Moeding on color palettes, finishing options, and making test tiles, for five unique glazing recipes translated into industrial production yet expressive of artistic craftsmanship on prefabricated terra cotta forms. When a project has many different custom colors like Tykeson Hall, glaze becomes the most cost effective option. Images this page clockwise from upper left: Kilns 1904, Perth Amboy Terracotta Company factory, New Jersey, from *Geological Survey of New Jersey, Vol. IV, Clay Industry* (image open source wikiwand); Modern kilns, Moeding factory in Germany (Image courtesy Shildan Group); Tykeson Hall terra cotta test tile mock-ups on site, photo M. LaFoe; Making test tiles in Germany at Moeding's R&D lab, a partner of Shildan (Image Shildan Group); Glaze design color studies in the OFFICE 52 Architecture studio; Moeding's R&D lab, Germany, glaze design process (this & images hereafter courtesy Shildan Group); Test tile fabrication Germany; Moeding extruded terra cotta production, Germany; Page 24: Moeding R&D lab, glaze testing/development.

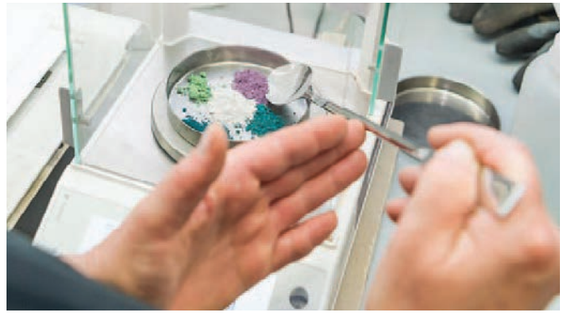




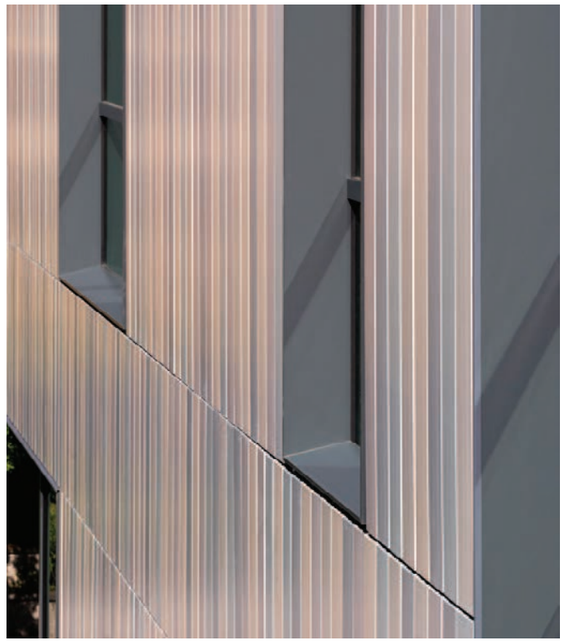
PHOTOGRAPHY BY MICHELLE LAFOE | OFFICE 52 ARCHITECTURE AND COURTESY SHILDAN GROUP, AS NOTED IN SIDE TEXT.

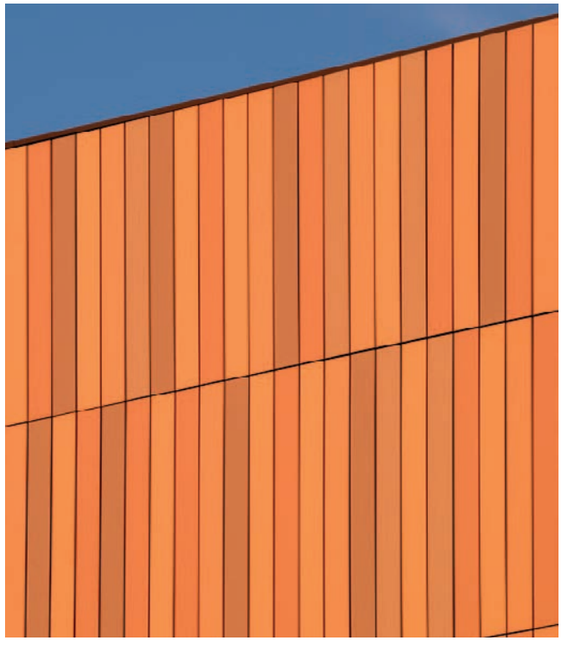


Design of the ceramic glazing to maximize its unique ability to interact with light and reach its full potential as a material was crucial. We worked collaboratively with the fabricator Shildan Group | Moeding regarding color, their glaze recipes, test tiles, and measures to reduce carbon footprint.



PHOTOGRAPHY COURTESY SHILDAN GROUP.





PHOTOGRAPHY SINZIANA VELICESCU TOP LEFT AND BOTTOM RIGHT; MICHELLE LAFOE TOP RIGHT (TYKESON HALL) AND BOTTOM LEFT (UO CAMPUS).

modelled all 77,000 bricks and 3,100 terra cotta pieces in BIM (Building Information Modelling) while working closely with the brick and terra cotta fabricators to define the technical and aesthetic parameters of the systems. We customized the prefabricated extruded terra cotta system and designed a new Norman Cross bond pattern specifically for this project. For the terra cotta panels, each unit was individually numbered on the back in accordance with our design development drawings so that installation at the building site could proceed smoothly and to ensure no one color repeated next to itself within the color field tile system. By choosing a single neutral-beige clay and using five custom color glazes, instead of more costly individual through-body molds, and a matte finish to accentuate natural light variations, we achieved desired aesthetics within a tight project budget.

Tempering the use of energy for environmental performance was crucial in the design. Terra cotta and brick are some of the best materials in embodied energy. Sustainably sourced clay and ceramics are the least energy intensive and have the lowest environmental impact, generating the least CO2 in production compared to a variety of other commonly-used building materials

Color Development

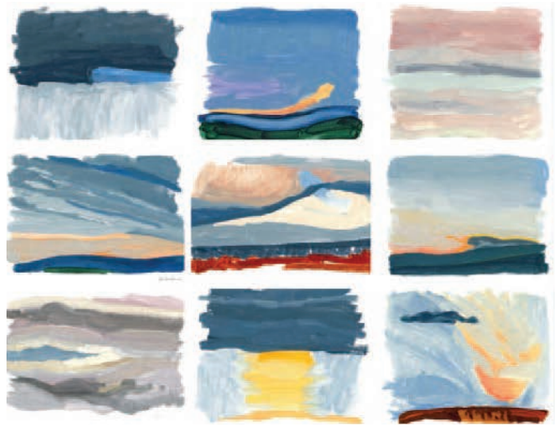
Brick absorbs light, glazed terra cotta reflects it. You see the shadows of trees in the unglazed brick, the nuanced light of the sky in glazed terra cotta. We wanted to embrace this sensory perception of catching the light.

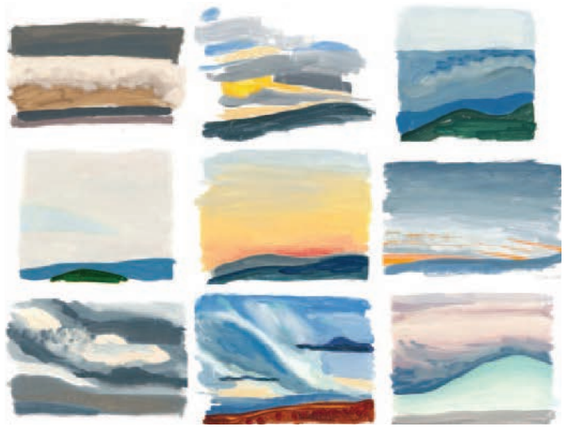
There are several factors that influence the outcome of a terra cotta façade design: the form or shape of the terra cotta pieces (convex, concave, flat), color, texture, and finish.

When we design, we approach color as a material and consider the three-dimensions of color space. Primary components of color in architectural glazing are hue, value and chroma. Hue is the closest "pure" color, value is its lightness, and chroma is the difference from the closest grey. Some colors develop a unique effect on a surface due to the way in which they respond to light. With Tykeson Hall, the interaction with light is due to the glaze minerals and matte finish. We based the glaze colors on five distinct regional landscape tones and worked a long time with the fabricator on getting the right glaze palette so it goes very well with the natural colors around the building - working with the trees and older buildings next to it.

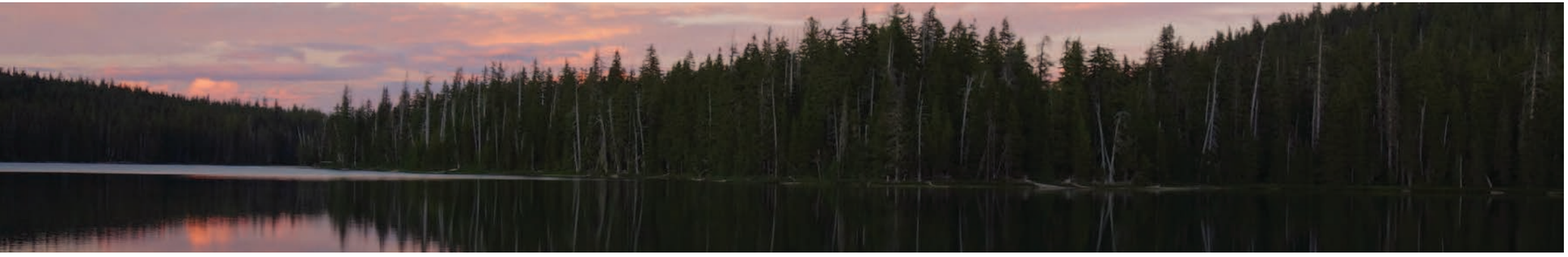
We looked at the surface qualities, color, luminosity and opacity of glaze that influence light as an outdoor visual experience in the Pacific Northwest. Instead of simply glazing the exposed façade tile surface, we glazed five of six sides of each tile panel, producing a subtle yet rich three-dimensional effect. Glazes themselves are three-dimensional with variation. Conceptually they are a simulated geological process in that heat and pressure are used to create durable surfaces.

We also look to the future by understanding the past from Mayan, Babylonian, Greek and Etruscan terra

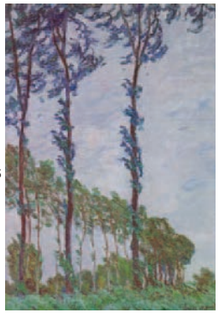




OIL PAINTING VIGNETTES MICHELLE LAFOE.



Perceptual effects of light and color. Claude Monet, L'Orangerie Paris Water Lily paintings (upper left); Poplar series Epte River (upper right) near Giverny, with latitude and ambient light similar to Oregon and Pacific Northwest landscapes (lower left and right).



PHOTOGRAPHY BOTTOM 4 IMAGES MICHELLE LAFOE; TOP 4 UPPER RIGHT *MONET IN THE '90S* EXHIBITION CATALOGUE, MUSEUM OF FINE ARTS BOSTON 1990 (WHEN LAFOE LIVED IN BOSTON); UPPER 2 RIGHT IMAGES FAR LEFT, *MONET WATER LILIES THE COMPLETE SERIES* 2016, LOOKED AT PAINTINGS WITH AND WITHOUT WILLOWS AT L'ORANGERIE WHEN IN PARIS, FRANCE.

PHOTOGRAPHY THIS PAGE CHRISTIAN COLUMBRES.

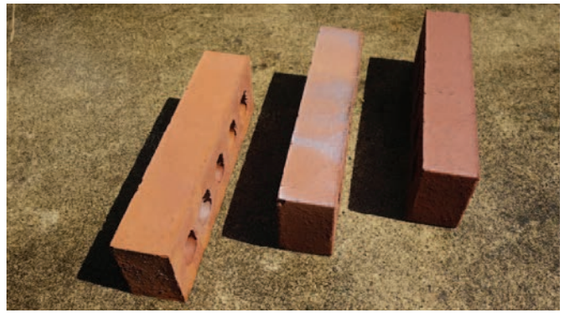
cotta processes to Gaudi, Sullivan, and contemporary innovation. My previous architectural research on glaze production and development while on a Fulbright Scholarship in Italy led us to Luca della Robbia's work (Italy) and Furstenzug-Dresden's Procession of the Princes exterior tile wall mural (Germany). Clay body and glaze chemistry was unique to each workshop. Much of Renaissance glazing techniques can be attributed to della Robbia, with tin-glazed terra cotta ceilings (mid-15th century) and use of brilliant white against a concave blue ground for perceptual effect. We also looked at Mayan art and architecture, which included fired clay and brightly colored pigments from the first millennium BC. Before firing, the surface would be covered in slips, or water-dissolved mineral mixtures, to create specific colors. Simultaneously we looked at the Pacific Northwest landscape and its quality of light in relation to Claude Monet's eight large interior water lily wall murals residing in the L'Orangerie in Paris, works of astonishing effect that we had visited on several occasions. What if we turned this perceptual experience inside out for a glazed façade application, we pondered, and created a color field that interacted with the outstanding qualities of the Pacific Northwest region's light.

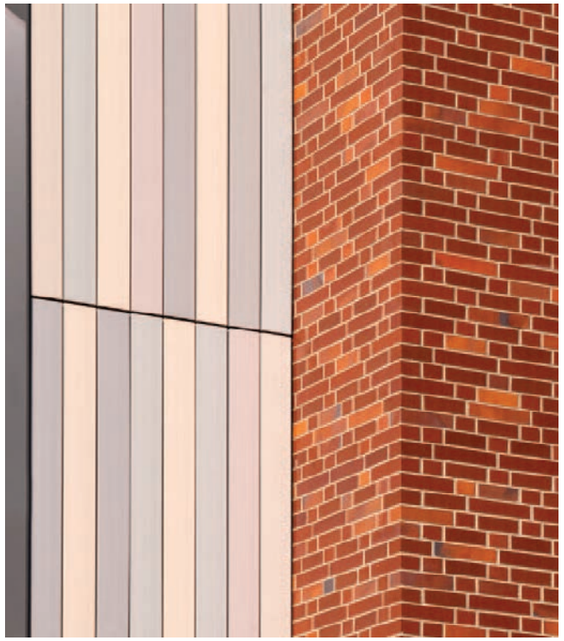
Our studio worked with the terra cotta fabricator from form to finish. We produced vertically-oriented, in-studio models, made test tiles and on-site mock-ups prior to construction for a highly aesthetic glazing system. We did the same for the brick with the brick manufacturer, building dry-stack mockups in the local brickyard and a contractor-built, full-size mock-up on site. For brick we used a blend of locally sourced Oregon and Washington clay, installed using a custom Norman Cross Bond pattern we designed specifically for this project. We thoughtfully designed aluminum window framing and brick mortar colors to enhance the overall façade composition with the brick and terra cotta.

Manufactured by Shildan and shipped from a production facility in Germany, the customized terra cotta rainscreen panels and glaze attenuation interact with the refraction and reflection of light, giving the façade a corresponding dynamic that is perceived differently depending on the season and viewing angle.

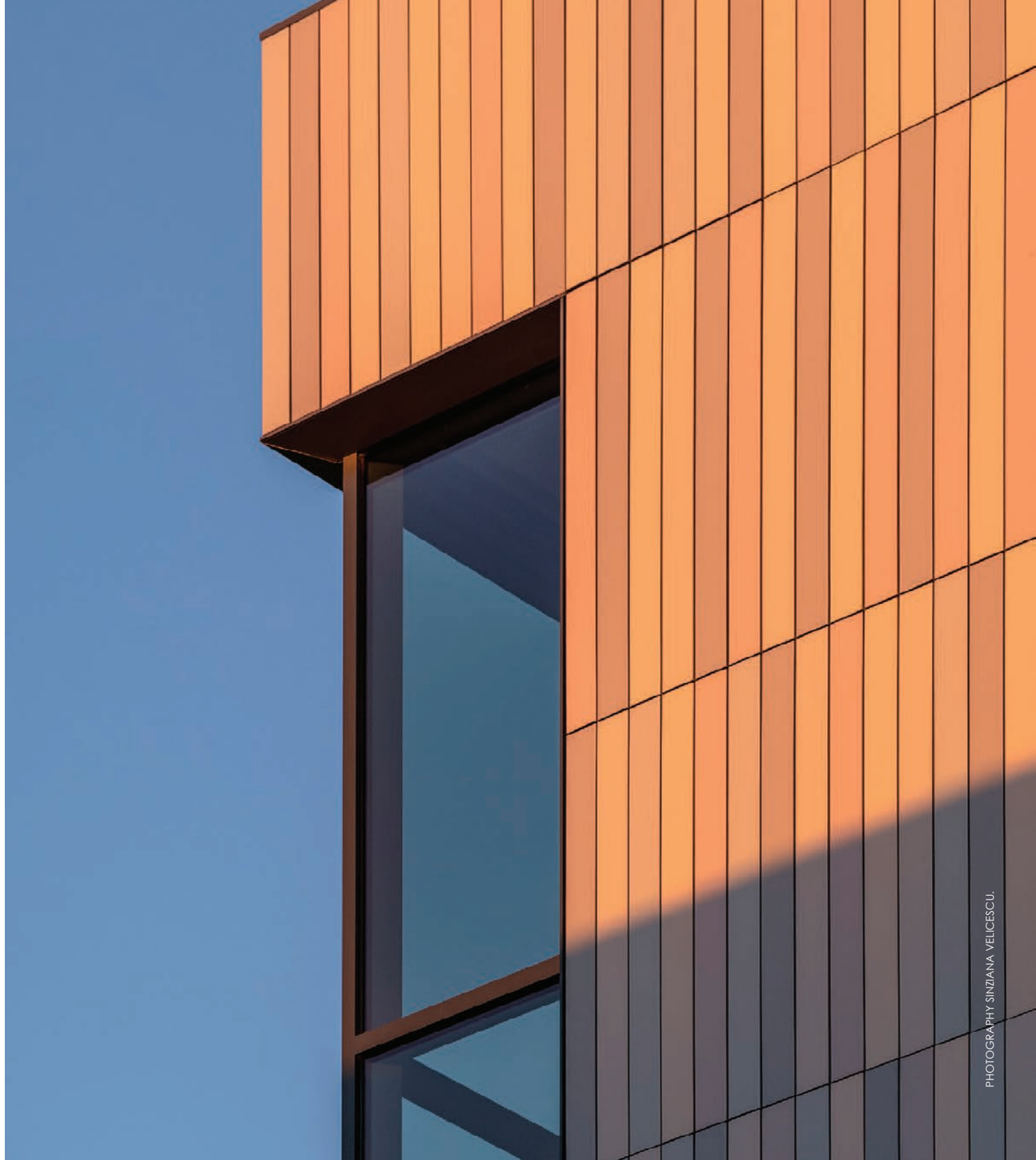
Design details: interior wood ceiling joints align with exterior window mullions and Tykeson terra cotta system module.

PHOTOGRAPHY PAGE 25 SINZIANA VELICESCU; THIS PAGE UPPER TWO PHOTOGRAPHY BY CHRISTIAN COLUMBRES, BOTTOM TWO SINZIANA VELICESCU.

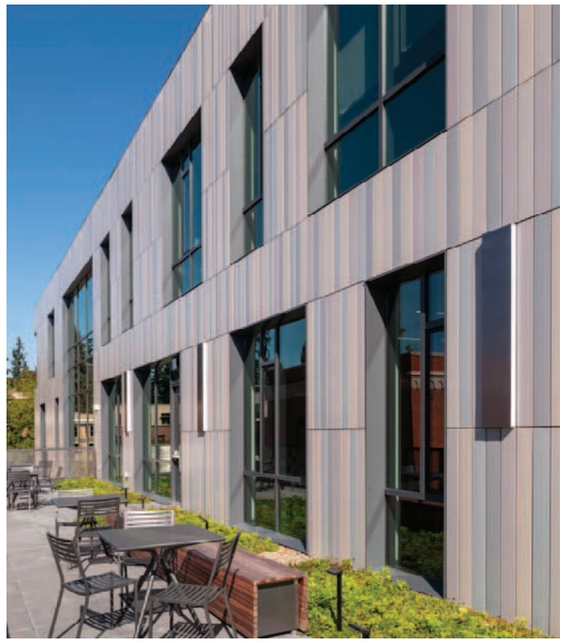


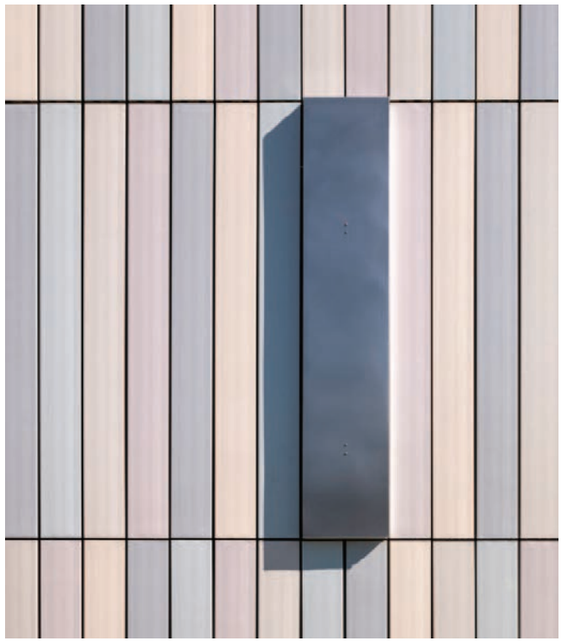


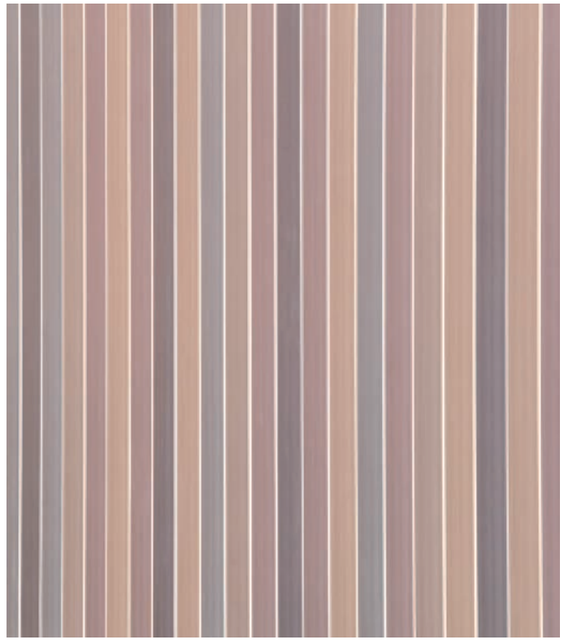
PHOTOGRAPHY LEFT BOTTOM MICHELLE LAFOE; TOP AND BOTTOM RIGHT SINZIANA VELICESCU.

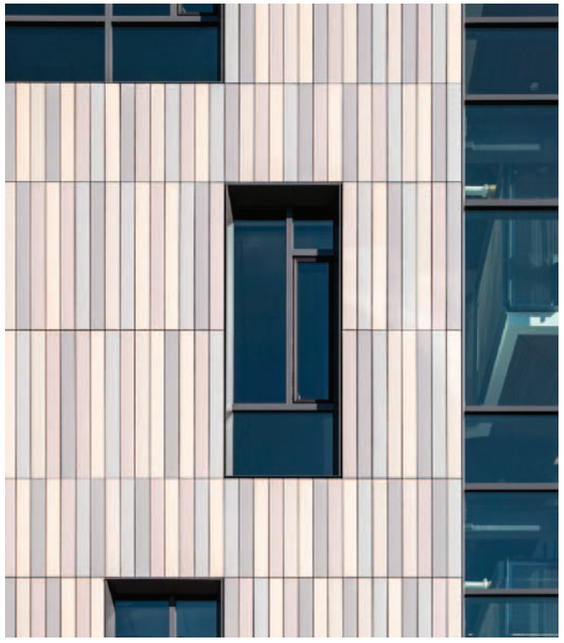


PHOTOGRAPHY SINZIANA VELICESCU.

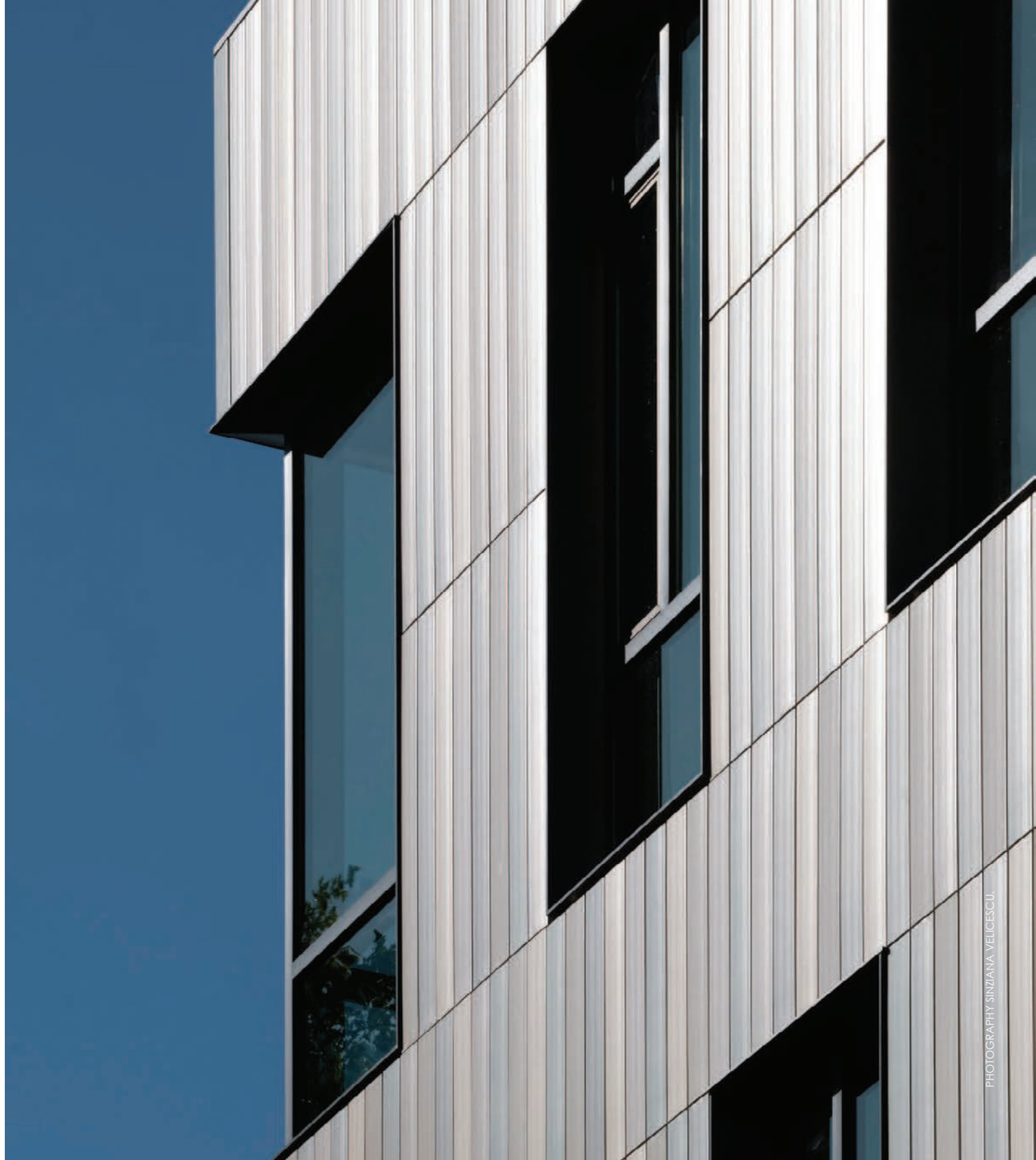








PHOTOGRAPHY SINZIANA VELICESCU.



PHOTOGRAPHY SINZIANA VELICESCU.

Authors' Biography

Michelle LaFoe, AIA, is a founding principal of OFFICE 52 Architecture, an award-winning firm in Portland, Oregon, USA. She is a practicing architect, accomplished artist, and a former Fulbright Scholar to Italy with advanced degrees in architecture, fine arts, and history. Her practice and studio work focus on poetically practical material applications for sustainable, high performance building solutions. Recognized for her research, she looks to the future of a material and innovative fabrication processes by understanding its history in conjunction with hands-on experimentation, in this case with architectural ceramics. Michelle recently coauthored *Form and Dichroic Light,* a monograph with a foreword by Cesar Pelli, FAIA, featuring the firm's competition-winning design for Scott Hall at Carnegie Mellon University in Pittsburgh, PA, USA.

Isaac Campbell, AIA, NCARB, is a founding principal of OFFICE 52 Architecture. For 30 years his work has focused on creating innovative designs that integrate place, program and materiality for sustainable, high performance building solutions at a variety of scales and building types. He honed his expertise on the integration of artistic vision with the design of technically sophisticated buildings and their enclosures while working for a decade with Cesar Pelli, FAIA. Isaac's work includes Scott Hall, the new Nano-Bio-Energy Technologies Building for the College of Engineering and the Wilton E. Scott Institute for Energy Innovation at Carnegie Mellon University. His design work has been recognized internationally through awards and publications. He received his degrees from Rice University. He grew up in Alfred, New York and studied at Alfred University, home of the prestigious New York State College of Ceramics.

OFFICE 52 Architecture

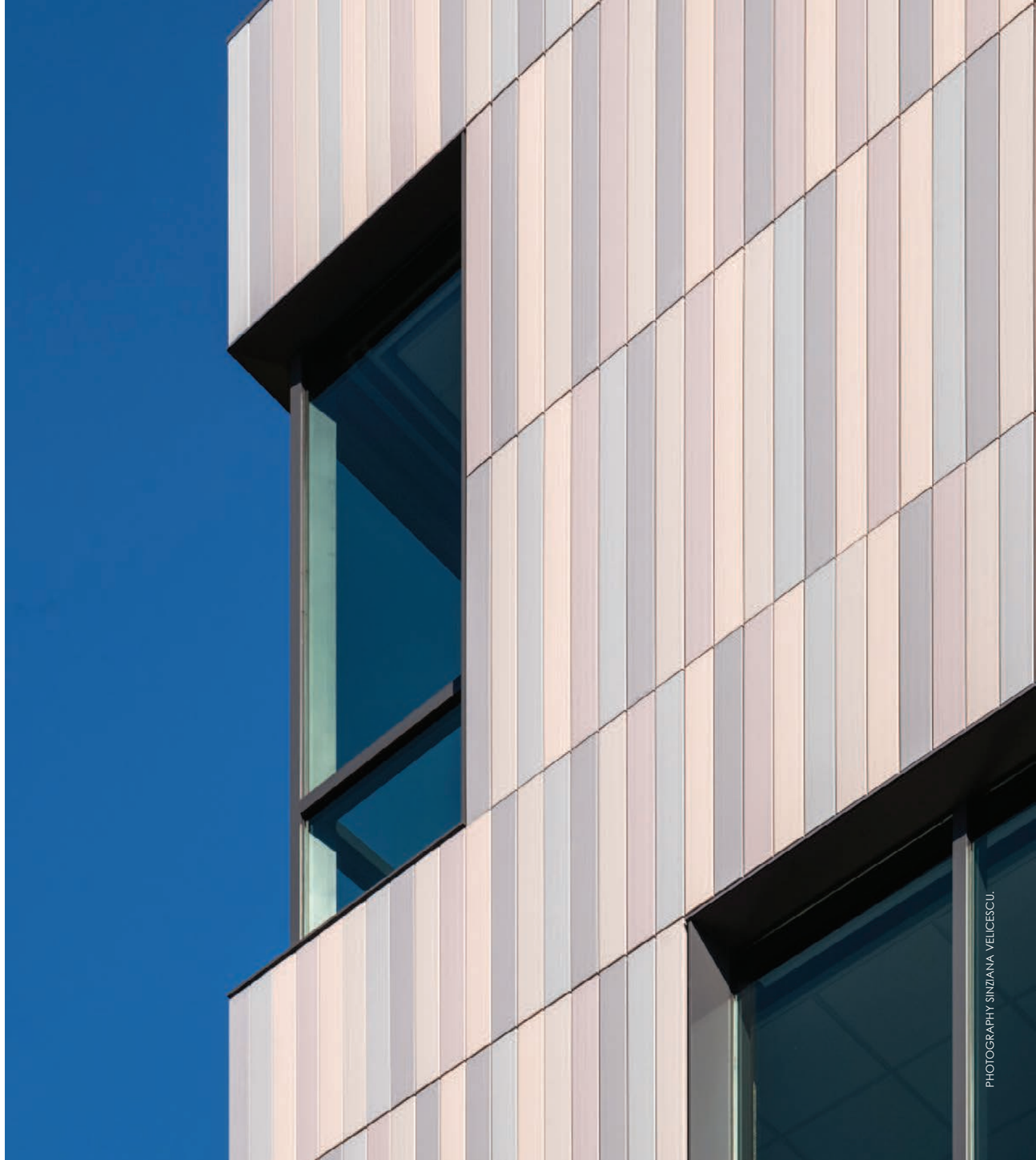
A recent article, *Aesthetic Nuance: Tykeson Hall*, describes the façade design process in greater detail. Our studio continues hands-on research and development with ceramic glazes | finishes and extruded terra cotta panel shapes composing ceramic assemblies for architectural applications. This includes glaze and solid | void shape experimentation for cost-effective ceramic components that combine poetic craft elements with industrial prefabrication, as well as key sustainability attributes revealing the full potential of the material in a world addressing climate change.

PROJECT CREDITS

Client University of Oregon
Design architect
OFFICE 52 architecture
Architect of record
Rowell Brokaw
General contractor Fortis Construction Inc.
Interior design and programming RMA Studio
Sustainability consultant
Brightworks Sustainability
Environmental | energy consultant Glumac
MEP Systems West Engineers
Civil KPFF Consulting Engineers
Structural Hohback Lewin, Inc.
Tykeson building landscape
PLACE Studio
The Ellipse landscape
LandCurrent

SELECTED SOURCES

Terra cotta rain screen
Shildan Group
Terra cotta glaze design
OFFICE 52 | Shildan | Moeding
Terra cotta installer Streimer
Brick Mutual Materials
Brick installer Davidson's Masonry Inc.
Fenestration glass Vitro
Insulated glass units Hartung
Glass installer Culver Glass Company



PHOTOGRAPHY SINZIANA VELICESCU.