WHEN FORM REALLY DOES FOLLOW FUNCTION:

Aesthetics Informed by Environmental Conditions

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INTRODUCTION

A common misconception is that historical building styles and ornamental articulation were mere aesthetic statements. Historically, buildings were empirically designed accounting for the climate/environment, culture, and locally available materials. A building constructed in a hot, arid region of the world had a significantly different appearance than a building constructed in a cold and wet climate. As such, buildings naturally responded to the environmental forces, such as wind, sun, and rain, through overall form as well as ornamental articulation.

The introduction of the International Style, following World War II, and the concurrent wider use and affordability of air conditioning and other environmental controls, resulted in a shift away from building articulation and materials being integrated into building designs to improve environmental performance. With the recent sensitization of environmentally responsible design and heightened awareness of carbon footprints, a survey of architectural history can provide valuable insight on how to better integrate our buildings into the environment. This paper explores historical building typology, along with specific ornamental components and materials, and their intentional use to address the environmental conditions of improving thermal comfort, reducing maintenance costs, and minimizing water infiltration. Designers have renewed appreciation for this approach and are revisiting these concepts today.

EXTERNAL FACTORS

Multiple factors affect design—particularly the design of articulated ornaments meant to address the function of the building. The most prevalent include environment, code requirements, human comfort (i.e., heating and cooling), and structural factors. Historically, the design and articulation of buildings naturally responded to environmental forces. Roof structures and classical façade elements, such as cornices, water tables, window surrounds, and plinths, were not only aesthetically pleasing, but also served important functions relative to moisture management and thermal comfort.

Figure 1 – View of existing street wall adjacent to Central Park in New York City. Photo courtesy of http://elitechoice.org/2010/06/26/high-end-apartments-in-manhattan-are-back-to-its-old-high/.

Environmental

Environmental conditions primarily focused on exterior climate and weather patterns, including temperature, sun, wind, rain, and other forms of precipitation. This often was resolved in how the building was positioned on a site (i.e., passive solar, natural ventilation based on wind direction, roof slopes oriented for water management, etc.), as well as how the exterior façade and structure of the building would be utilized to minimize the effects of the environmental conditions to the occupants, while also being maintainable. Additionally, these factors are examined relative to human comfort—both prior to and following the introduction of artificial climate controls. These climatic demands often resulted in significant differences in aesthetics in different regions of the world—i.e., adobe structures in the Southwest would not be functional in the northern portion of the United States, as they could not be maintained in those climates. Designers addressed environmental factors in the buildings with a multitude of elements, including the exterior envelope components, materials, and aesthetics.

One of the most significant influences on architectural ornament and building form is the macroclimate of the region in which the building is constructed. Buildings in cold climates invariably have high thermal mass or significant amounts of insulation. They are usually "tighter" in order to limit heat loss and air infiltration. Thus, openings such as windows tend to be small, protected, or nonexistent. Buildings in warm climates, by contrast, tend to be constructed of locally available materials, which in some instances have tended to be lighter materials, such as straw and bamboo, to allow for air movement and greater potential for evaporative cooling. The incorporation of loggias, overhangs, and light courts in warmer climate design often illustrated a specific aesthetic, dependent on the locally available materials in each climatic region. The color of cladding materials can also be a consideration of architectural design relative to climatic regions (i.e., darker colors would be utilized in cooler climates to absorb the sun for passive heating, while buildings in warmer climates would utilize lighter colors to reflect the sun).

Climatic influences on architectural forms are substantial and can be extremely complex. Mediterranean vernacular, and that of much of the Middle East, often includes a courtyard with a fountain or pond; air cooled by water mist and evaporation is drawn through the building by the natural ventilation set up by the building form. Similarly, vernacular architecture of the southwestern United States and other desert-type climates, such as North Africa, often has very high thermal mass and small windows to keep the occupants cool during the day and provide warming by thermal lag at night. In many instances, these buildings also include chimneys to create a pressure differential to draw air through the interior spaces. These varied approaches were developed by trial and error over generations of building construction—often long before the scientific theories and "architectural design" explained how and why they work.

By contrast, buildings constructed in a continental climate (climate with significant seasonal temperature and precipitation changes throughout the year), characteristic of the central parts of Asia and North America, must accommodate significant variations in temperature and humidity, depending on the time of year. Thus, the buildings must be more adaptive, incorporating features such as operable windows, storm windows, shutters, adjustable overhangs, and louvers.

Buildings also adopt different forms and ornamentation depending on precipitation levels in the region. Buildings in tropical regions that frequently flood are often built on stilts. Steeply sloped roofs are prevalent in areas with significant precipitation to readily shed water or snow, thus preventing excessive loading on these structures. Yet in some instances, the design is intended to use the precipitation for irrigation purposes—or, in the case of snow—to allow it to accumulate and provide improved thermal performance. Similarly, areas with high winds will lead to building-optimized structural forms and orienting the buildings to present minimal area to the direction of prevailing winds. This optimization of structural form with regard to buildings is apparent at present with the race to build the next tallest building in Asia and the Middle East.[1]

Code Requirements

More recently, building codes have played a role in influencing architectural articulation and massing. Building codes were typically enacted in response to hazardous situations that threatened public health, safety, and welfare; or to natural disasters such as floods, fires, and earthquakes. Fire protection was the first major issue leading to the establishment of early building codes. In 1896, the National Fire Protection Association (NFPA) was founded with the intention of establishing uniform sprinkler standards for the mills and warehouses of the northeastern United States. First published in 1897, NFPA standards were used until the mid-twentieth century.[2] Thus, many of the code requirements relative to the building ornament, building layout, and construction materials were related to fire protection of the structure and its occupants.

Figure 2 – Views of projecting bays on Chicago skyscraper buildings in response to the Chicago Building Codes of 1905.

Like fire protection, many of the health-, safety-, and welfare-related aspects of current codes originated in the nineteenth century when reform movements were working to correct urban social issues such as density, decay, light and air, poor living conditions, and occupant safety. These reformations resulted in the establishment of various codes and ordinances—for instance, the New York Tenement Laws authored between the 1850s and 1910.[3] These laws addressed minimums for living conditions, not specifically relating to building construction, but rather occupancy and cleanliness. In cities such as New York and Chicago, this also resulted in the incorporation of parkland or green spaces within the urban areas, which helped to define, if not ornament individual buildings rather than the aesthetic of the street wall, as shown in *Figure 1*.

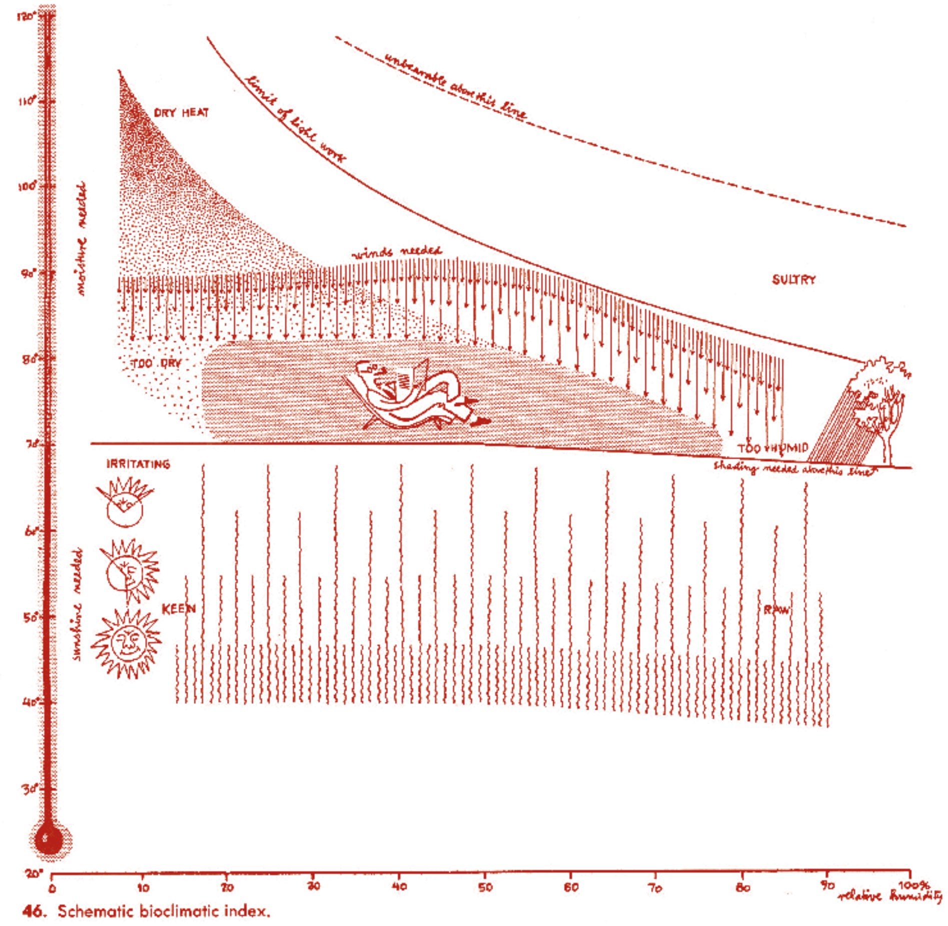


Figure 3 – Schematic diagram of Victor Olgyay's Bioclimatic Chart.[11]

New standards were developed in the early twentieth century in response to catastrophic events and other natural disasters. For instance, the NFPA 1927 Building Exits Code, later incorporated into the Life Safety Code and other fire safety of various building codes—including the New York City Building code—were developed in response to the 1911 New York City Triangle Shirtwaist Company fire.[4] Similarly, the 1903 Iroquois Theater fire in Chicago contributed to the advent of the life safety code.[5]

Additionally, local codes, such as the 1905 building codes in Chicago and New York, were focused on the existing street wall; and, in an attempt to limit the cavernous nature of the existing streets and maintain the minimum requirement for light and air created by the introduction of the skyscraper, setbacks were instituted. The introduction of the mandatory setbacks worked to define the style of many of the early 20th-century skyscrapers in these regions, thus resulting in the "wedding cake" building forms, as well as the projecting bay window, in a desperate attempt by architects to recapture some of the valuable square footage extending over the public way. The development and widespread popularity of the Art Deco style in architecture can in part be attributed to the code requirements in Chicago and New York (*Figure 2*).

Cultural

Many of the building forms, rather than applied ornamentation, are related to cultural influences. In turn, they are often guided by environmental and local traditions, as well as readily available materials and knowledge. The way of life of the building occupants and the ways they use their shelters are of great influence on building forms. The size of family units, the way in which space is shared, how food is prepared and eaten, how people interact, and many other cultural considerations will and have affected the layout and size of dwellings.

Culture also has a great influence on the aesthetics of buildings, as occupants often ornament their buildings in accordance with local customs and beliefs. Thus, as previously discussed, buildings in warm, arid climates take significantly different forms than buildings constructed in cool or humid climates, which in turn translates to the identities of these buildings in a particular culture. Cultural influences are so strong throughout architectural ornamentation that many of the features are named for the culture they originated from relative to the environmental factors that they were addressing. These cultural influences were most prevalent in vernacular architecture, which is designed based on need, availability of materials, and reflection of local traditions.

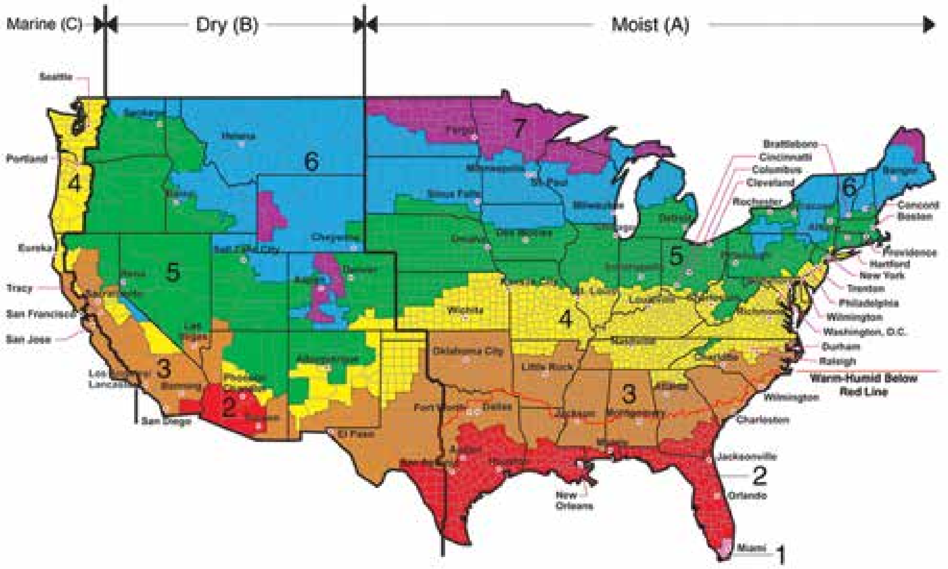
Vernacular architecture generally evolves over time to reflect environmental, cultural, social, economic, historical, and technological context. Vernacular architecture is truly functional architecture, meaning that ornamental elements and forms were strictly driven by function. This can be contrasted with polite architecture,[6] which is characterized by stylistic elements of design intentionally incorporated for aesthetic purposes, which go beyond or may not even address a building's functional requirements.

Human Comfort

Contemporary architects incorporate principles of sustainable design due to the numerous environmental, cultural, social, economic, historical, and technological demands of the world. Yet, the challenge of balancing climate control and building functionality—while combating the harsh forces of wind, water, and sun—presented a new set of obstacles to architects and engineers in the mid-twentieth century with the rise of glass and metal temples made popular by the International Style.

"Bioclimatic" is relating to the interrelation of climate and the activities and distribution of living organisms.[7] Thus, bioclimatic architecture refers to the design of buildings and spaces (interior, exterior, and outdoor) based on local climate and aimed at providing human comfort, making use of solar energy and other environmental sources. A schematic of the bioclimatic index, in *Figure 3,* is used as an illustration to describe the needs for idealized human comfort. The graphic highlights the critical points for cooling, heating, shading, need for moisture, etc. Bioclimatic data has been collected for specific regions for many years.

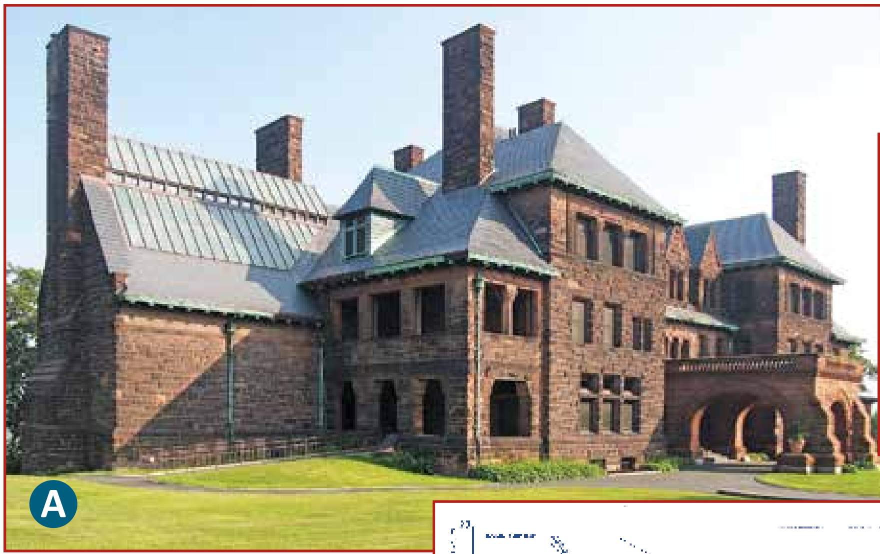
There are generally eight climate regions in the United States defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The map in *Figure 4* shows the International Energy Conservation Code (IECC)/ASHRAE climate



All of Alaska in Zone 7 except for the following Boroughs in Zone 8: Bethel, Dellingham, Fairbanks, N. Star, Nome North Slope, Northwest Arctic, Southeast Fairbanks, Wade Hampton, and Yukon-Koyukuk

Zone 1 includes: Hawaii, Guam, Puerto Rico, and the Virgin Islands

Figure 4 – Climate zones map of continental U.S. by IECC/ASHRAE, last modified in 2015.



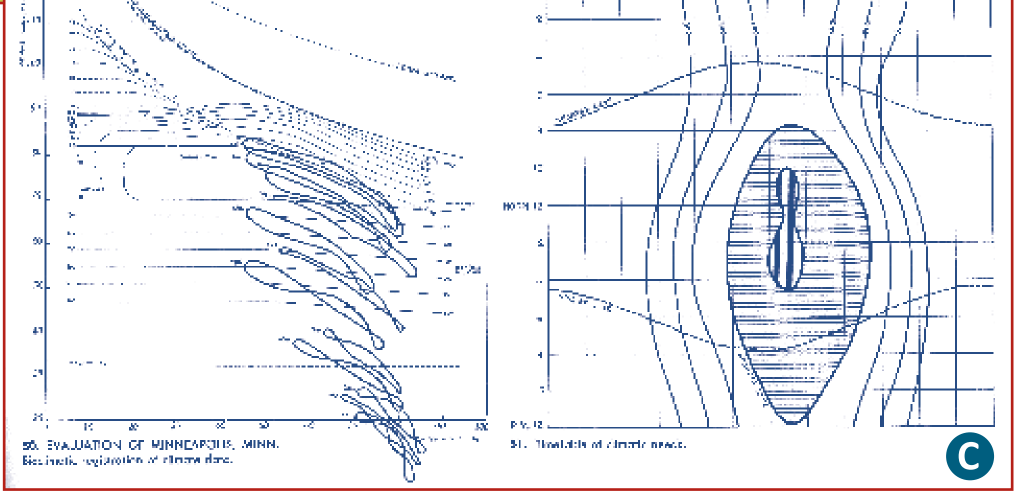
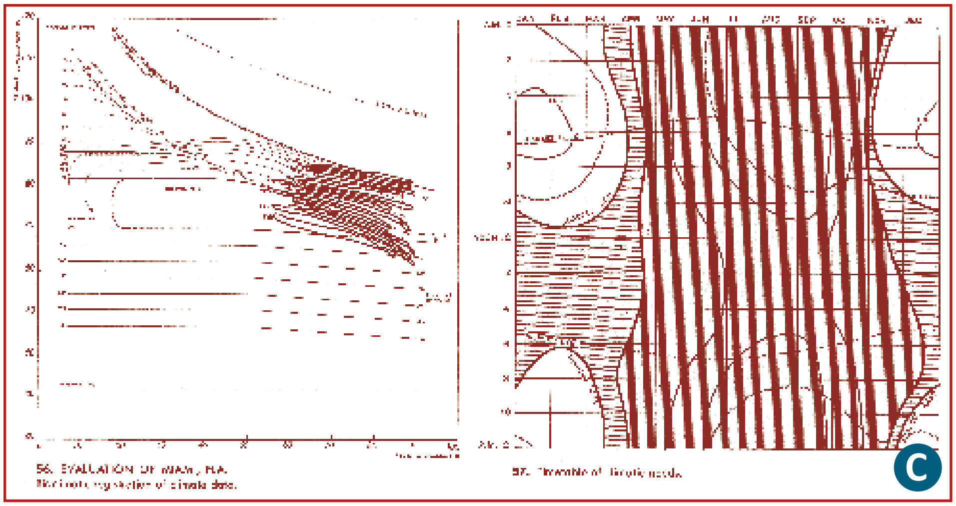


Figure 5 – Images of James J. Hill house, located in St. Paul, Minnesota, showing the north façade (5A) and south façade, with more window openings (5B),[12] representing typical regional construction for Minneapolis, Minnesota. Figure 5C shows the registration of bioclimatic data and the timetable of climatic needs.[13]

zones for the United States. The zones are defined according to county aggregations and correspond to the following generalized climate categories: 1 = very hot; 2 = hot; 3 = warm; 4 = mixed; 5 = cool; 6 = cold; 7 = very cold; 8 = subarctic. Within each of these categories, there is a moist (A) and dry (B) region, as well as a marine (C) region.[8] The varied climate regions and humidity result in different heating and cooling needs throughout the year. For example, charts of the bioclimatic data for Minneapolis, Minnesota (zone 6 – moderate moisture) as compared with Miami, Florida (zone 1 – extreme moisture) have been included to show the differences in the need for heating and cooling and the different types of architectural forms that result from these climate demands.

Historically, the design for human comfort was typically integrated into the exterior cladding and space layout of the building, with projecting elements for shade and cooling, light courts, and large operable windows with window surrounds in large urban buildings for the introduction of light and air to the buildings due to the lack of artificial temperature controls. With the introduction of these systems, beginning

Figure 6 – Image of historical vernacular building located in southeastern region, showing the typical regional construction (6A), image of contemporary house design in Florida mimicking much of the elements of the historic style (6B), and Miami, Florida Registration of Bioclimatic Data and timetable of climatic needs (6C, at top of next page).[14]



in the 1890s, changes to overall building form, material expression, and integral ornamentation were diminished, as seen in the International Style. Shading and cooling were minimally achieved by the use of internal window treatments and early air conditioning. Despite having artificial climate controls, these buildings did not provide a significant improvement in human comfort, as compared with their masonry predecessors.

The bioclimatic charts as illustrated in *Figures* 5C and 6C are utilized to perform regional evaluations of climatic situations. The charts plot combined temperature and relative humidity data at regular intervals throughout the year to show the general climatic characteristics of a region. The number of points falling into different sensation categories indicate the importance of various climatic elements for specific regions, such as the need for shading, radiation, wind, etc. Based on the bioclimatic needs, there are generally four major climate zones in the United States. These include cool, temperate, hot-arid, and hot-humid. Minneapolis, Minnesota, is a cool climate requiring heating and is used as an example, while Miami, Florida, is a hot-humid climate requiring cooling and is also illustrated as an example.[9]

Heating

Heating in structures can be accomplished in multiple ways, including natural systems such as solar, fireplaces, geometry; and more recently, artificial systems, including radiators and forced air. The graphics in *Figure* 5, included for the Minneapolis bioclimatic data, indicate that this is a climate that primarily requires heating throughout the majority of the year. Steep-slope roofs to catch sun and shed snow, as well as adjustable and limited window/door openings set back into the monolithic local Lake Superior sandstone walls, are shown in the James J. Hill house in St. Paul, Minnesota (completed in 1891). Minimizing air infiltration is a functional ornamental factor of a climate requiring significant heating. Steeper pitched roofs also enclose more living space with less surface exposure for the extreme cold temperatures and wind. Additionally, when constructed of darker-color materials, these spaces benefit from the passive solar heating as mentioned previously.

Cooling

Cooling in structures can be accomplished through natural ventilation and shading or mechanical systems. The graphics in *Figure* 6, included for the Miami bioclimatic data, indicate that this climate primarily requires cooling. The roof structures were constructed with large overhangs and more porous materials to create shade and allow heat to escape. Numerous window and door openings were incorporated in the façades of the building to create natural cross ventilation.

Other factors affecting human comfort and building forms include the introduction of plumbing, electricity, and elevators. The introduction of these systems meant buildings could be taller, denser, and utilized throughout all hours of the day, making our buildings work harder. The introduction of electricity and mechanical upgrades, including forced air heating and air conditioning, resulted in the obsolescence of the light court and the need for natural light and air, which in turn meant buildings could be constructed on entire city blocks with large floor plates without access to exterior windows. This allowed for new designs of the exterior façade elements, where windows

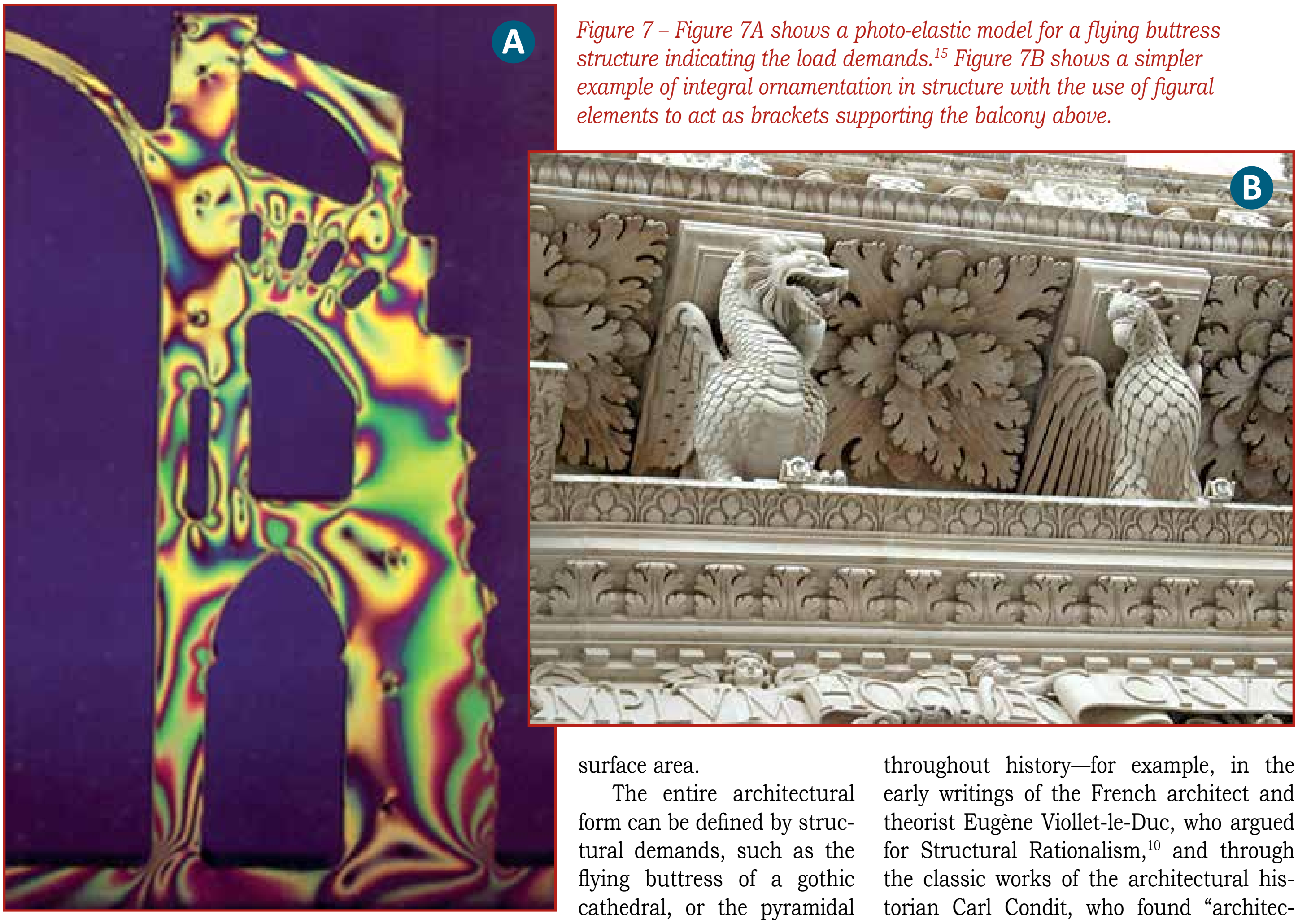


Figure 7 – Figure 7A shows a photo-elastic model for a flying buttress structure indicating the load demands.[15] Figure 7B shows a simpler example of integral ornamentation in structure with the use of figural elements to act as brackets supporting the balcony above.

could be inoperable and only provide light, rather than ventilation.

Structural Factors

"Form follows function" (as routinely stated by Louis Sullivan and later parroted by the architects of the Modern movement), is truly at the heart of the structure guiding the architecture of the building with many of the designers of the late 19th and early 20th centuries.

Examples of efficiency of form—both material and structural—exist throughout nature at all scales. Many of these simple practices have inspired, and in some instances, been adopted in architecture. Bees create honeycomb in a hexagonal shape that, when combined, maximize storage area for their honey, with minimal use of wax, to provide enclosure and stability as efficiently as possible. In architecture, Buckminster Fuller sought to enclose the maximum amount of space with flat components, using the tetrahedron. A more pure form is the igloo, using a sphere, which encloses maximum space with the least surface area.

The entire architectural form can be defined by structural demands, such as the flying buttress of a gothic cathedral, or the pyramidal forms of the load-bearing masonry structures such as the Monadnock building. The effect can also be as simple as the expression of the structure in the International Style, as seen in Mies Van der Roe's applied exterior column ornament to express the interior structure in Crown Hall.

Structure can also act as an ornamental element of the exterior façade, such as highly decorative columns, brackets, and other supplemental support. In *Figure 7A*, a photo-elastic model of a flying buttress structure indicates the load demands and the need for the form to be defined by these demands. Simply stated, through trial and error, masonry material was used efficiently to limit tension in the system. This was done while resisting the lateral thrust of the roof and wall structures while taking advantage of stone's most practical mechanical property: compression. A simpler example is also shown in *Figure 7B*, where figural elements are utilized to act as structural brackets supporting the balcony above.

Ideas relating to exposed or expressed structure of the architectural form and function of the building can be found throughout history—for example, in the early writings of the French architect and theorist Eugène Viollet-le-Duc, who argued for Structural Rationalism,[10] and through the classic works of the architectural historian Carl Condit, who found "architectonic expression" in the rationalism of the Chicago School of architecture. Great structural engineers such as Pier Luigi Nervi and Fazlur Khan have also analyzed and written on this. Nervi said that respecting what is structurally rational and economically prudent actually establishes the "correctness" and the "ethics" of building. Khan argued that well-detailed and efficient structures possess the natural elegance of slenderness and reason, and have possibly a higher value than the whims of a-priori aesthetics imposed by architects who do not know how to work closely with engineers and who do not have an inner feeling for natural structural forms.

ENVELOPE COMPONENT EXEMPLARS

As demonstrated throughout this paper, in most instances, ornamentation in the building envelope components were historically both functional and aesthetic. The intent was to improve creature comforts or the function of the exterior envelope of the building. For illustration purposes, envelope components discussed below will be divided into categories, including the elements that are integral to the building façades, such as projecting façade elements, window surrounds, and setbacks of openings, elements experiencing multiple exposures, or applied components such as awnings.

Projecting Façade Elements

Projecting elements generally refer to units that project out from the plane of the main façade. Projecting masonry elements that experience cracking and displacements are likely the result of accumulated stresses within the façade. These stresses are due, in part, to the inability of the wall construction to accommodate thermal and moisture movements of the cladding materials, as well as differential movements between the masonry and the underlying structure. While these elements served to protect the façade from distress related to water infiltration and temperature cycling, the cornices and water tables often became the sacrificial ornament as the extent and severity of distress increased and would ultimately be deemed “beyond repair.”

Figure 8 – Views of historic Chicago skyscraper showing historic image (8A) with cornice intact, same view with cornice removed (8B), distress at top floor terra cotta lintels (8C), and view of condition of existing steel upon removal of distressed terra cotta lintel units at upper floor (8D).

Cornices and Water Tables

Cornices and water tables are horizontal bands around the perimeter of the building that project from the adjacent plane of the wall and provide for water shedding away from the plane of the exterior façade. As these elements are the most exposed to the weather conditions—including rain, snow, and wind—distress is often related to corrosion of the anchorages in combination with unaccommodated movements.

In the mid-twentieth century, in harsh climates such as Chicago and New York, many of the cornices were removed in the name of public safety, due to the distress and the need to keep masonry units from “raining” down on the sidewalk. The removal of the cornices typically was not done with much sensitivity or consideration for long-term water management. Typically, the removal process included cutting steel elements flush with the plane of the wall and installing brick around the existing steel without any additional treatment. The act of cutting these cornices resulted in fewer large stone or terra cotta units falling to the sidewalk, but often accelerated deterioration of the portions of the building façade that had been previously protected by the water shedding of the cornice structures. By contrast, sections where cornices and water tables have remained experience significant distress from the elements, yet the remainder of the building façade below these projections is in remarkably good condition relative to water infiltration and corrosion-related distress.

At multiple buildings in the Chicago area, the authors have observed this phenomenon, and a few are included for reference in *Figure 8*. The first example is an early Chicago skyscraper building, constructed circa

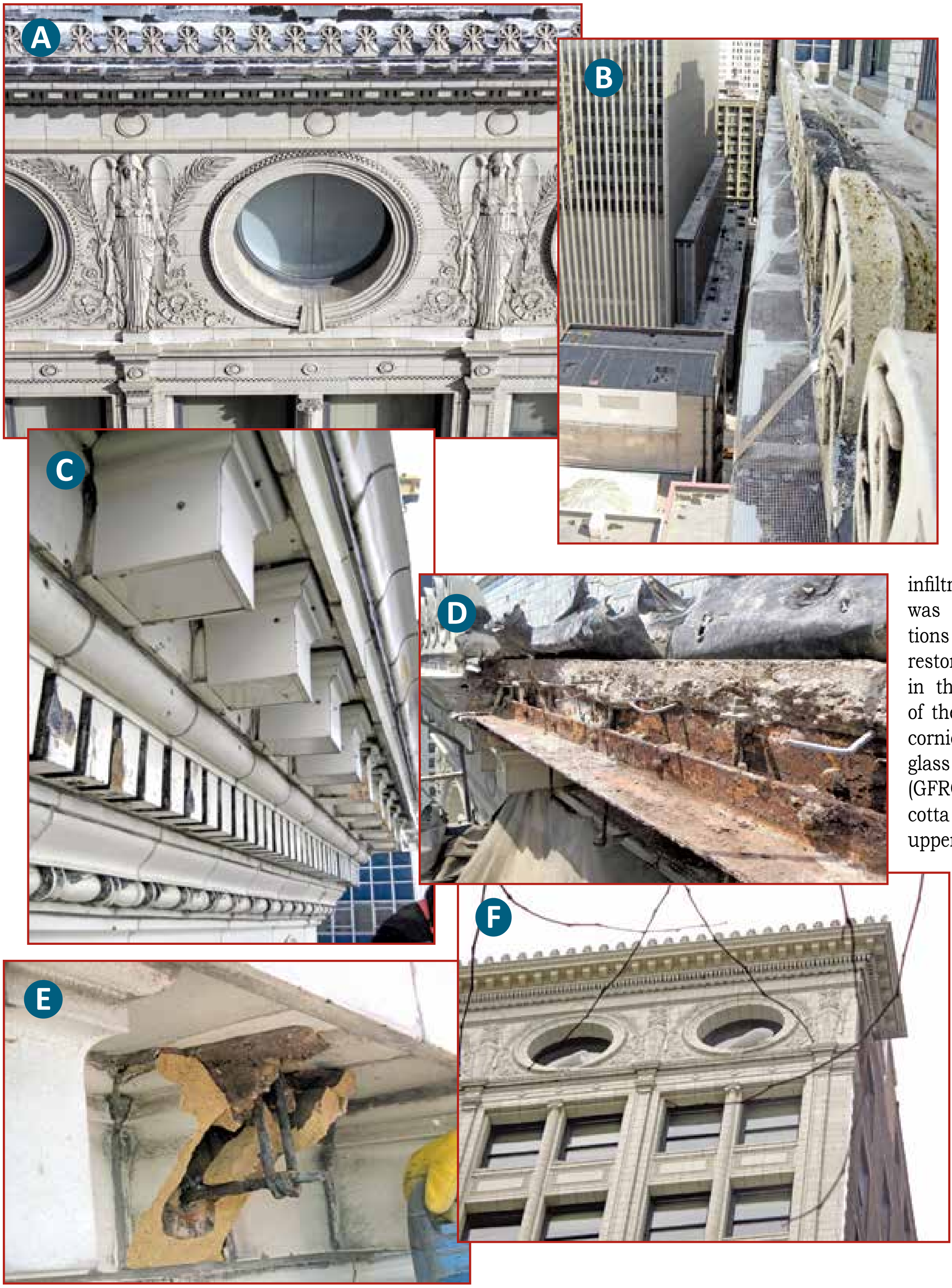


Figure 9 – Historical Chicago skyscraper. Figure 9A: Image from 2008, showing deteriorated cornice intact, and good condition of upper floors of terra cotta. Figures 9B and 9C: Images of the existing conditions, including temporary stabilization efforts to minimize elements falling to the street until replacement of the cornice. Figures 9D and 9E: Images of condition of the existing terra cotta and underlying steel observed during recent restoration work. Figure 9F: View of completed cornice restoration and view of upper-floor terra cotta intact.

1895, where the cornice was removed circa 1950s as described above. Note that *Figure 8A* is a historical image showing the cornice intact, which projected nearly eight feet from the plane of the building wall; while the image in *Figure 8B* shows the building from the late 1990s, with the cornice removed. The images in *Figures 8C* and *8D* show the typical distress conditions of the terra cotta units and corrosion of the steel supports above the top floor windows, which were protected from significant water infiltration until the cornice was removed. These conditions were observed during the restoration project completed in the early 2000s. As part of the façade restoration, the cornice was reinstalled with glass fiber reinforced concrete (GFRC) panels, and the terra cotta lintels and steel at the upper floors were repaired.

The second example is also an early Chicago skyscraper building, yet this example is one where the original cornice remained intact. The balustrade/parapet wall was reconfigured throughout the history of the building, yet the terra cotta cornice remained in place despite severe deterioration. While the cornice experienced distress related to water infiltration and corrosion of the embedded steel, the building façade below the cornice was in good condition—at least in part due to the water-shedding characteristics of the cornice. The images in *Figure 9* show the typical distress conditions of the terra cotta units at the cornice. *Figure 9F* also show the terra cotta at the top floor windows, which is in good condition, since it was protected by the cornice structure from significant water infiltration and corrosion-related distress.

Window Surrounds

Window surrounds were typically designed of the same or similar cladding material as the exterior façade, projected slightly from the face of the façade (not to the extent of cornices and water tables), and provided a masonry frame around the windows. The surround helps protect the windows from water infiltration and from water cascading down the building façade, as well as to help provide some shade to the occupants. The window surrounds, along with deep-set windows (and sometimes the inclusion of awnings), were all ways of improving human comfort, but also maintaining the large wood-frame windows. Protection is further enhanced when the masonry units themselves created drop profiles, or drips were incorporated into the units. Both help to reduce water running down the plane of the wall.

Figure 10 – Overall view of street façades showing cornice and deep-set windows, along with awnings (10A); close-up view of terra cotta window surround on corner of street (10B); view of street façade windows following restoration (10C on next page); view of alley facade compared with street façade in terms of window depth (10D on next page); view of deteriorated window frames and sashes and corroded steel at alley façade windows (10E and 10F on next page).

The authors have observed masonry window surrounds at multiple buildings, and a specific example of a Chicago skyscraper constructed in 1893 is included for reference in *Figure 10.* It should also be noted that this building originally had a cornice that was removed circa 1940s and has not been reconstructed to date. The images show a historical photo of the building following the completion of the upper-floor additions in 1903, as well as recent photos of one of the window surrounds at the corner of the building prior to the façade restoration that was completed in 2015. The windows on the street façades were set back from the plane of the masonry a minimum of 12 inches. Fabric awnings were installed early in the life of the building, yet were removed at an unknown later date as shown in the photos. Due to minimal distress (i.e., peeling paint related to deferred maintenance) observed at the wood windows on the street (south and west) façades, these windows were restored with only minor wood repairs to the frames, sashes, and sills. In contrast, on the same building, the wood windows on the alley (north) façade, which were generally in the same plane of the masonry façade, experienced significant decay, rot, and other deterioration of the wood. It should be noted that the most significant weather-related distress on buildings in Chicago is typically observed on the south and west façades. *Figures 10C* and *10D* show the comparison of the depth of the windows at the alley façade with those of the street façades. Figures 10E and *10F* show the conditions of the alley windows, which were ultimately replaced, as well as the corrosion on the embedded steel adjacent to the windows.

Dual-Exposure Façade Elements

Dual-exposure elements are projecting elements that generally experience wind loading from both sides. These tend to be located near the top of the building and are similar to many of the characteristics of the projecting elements. The original designs typically relied on the mass of the masonry and keying together of specific units in addressing overturning and to minimize water penetration.

Balustrades

These are ornamental rails and copings supporting a series of balusters (i.e., spindles) that can be single or multiple units. Balustrades were intended to act as monolithic elements with the function of the tensile bond capacity of the mortar, with mortar keys between units in combination with the metal bars extending through the units and across the top rail acting as the main load-resistance mechanisms. The function of balustrades are multiple, from reducing the possibility of a person falling off a stairway or roof edge, to zoning off an area for the purposes of privacy or limiting other unsightly functions of the building.

Finials

Finials, as originally constructed, were intended to act as monolithic elements with an overall resistance against overturning by means of the tensile bond capacity of the mortar in the joints between units, in combination with metal pin(s), as well as the cumulative weight of the units. Finial means "final," as these were the final elements to be installed on a roof or a tower. With the flexibility of available materials utilized in roofing applications today, the challenge of creating a watertight seal at the terminus of the roof is less prevalent. Historically, brittle materials, including ceramic or slate tiles, were utilized for roofing, thus waterproofing the terminus of a dome, steeply sloped structure,

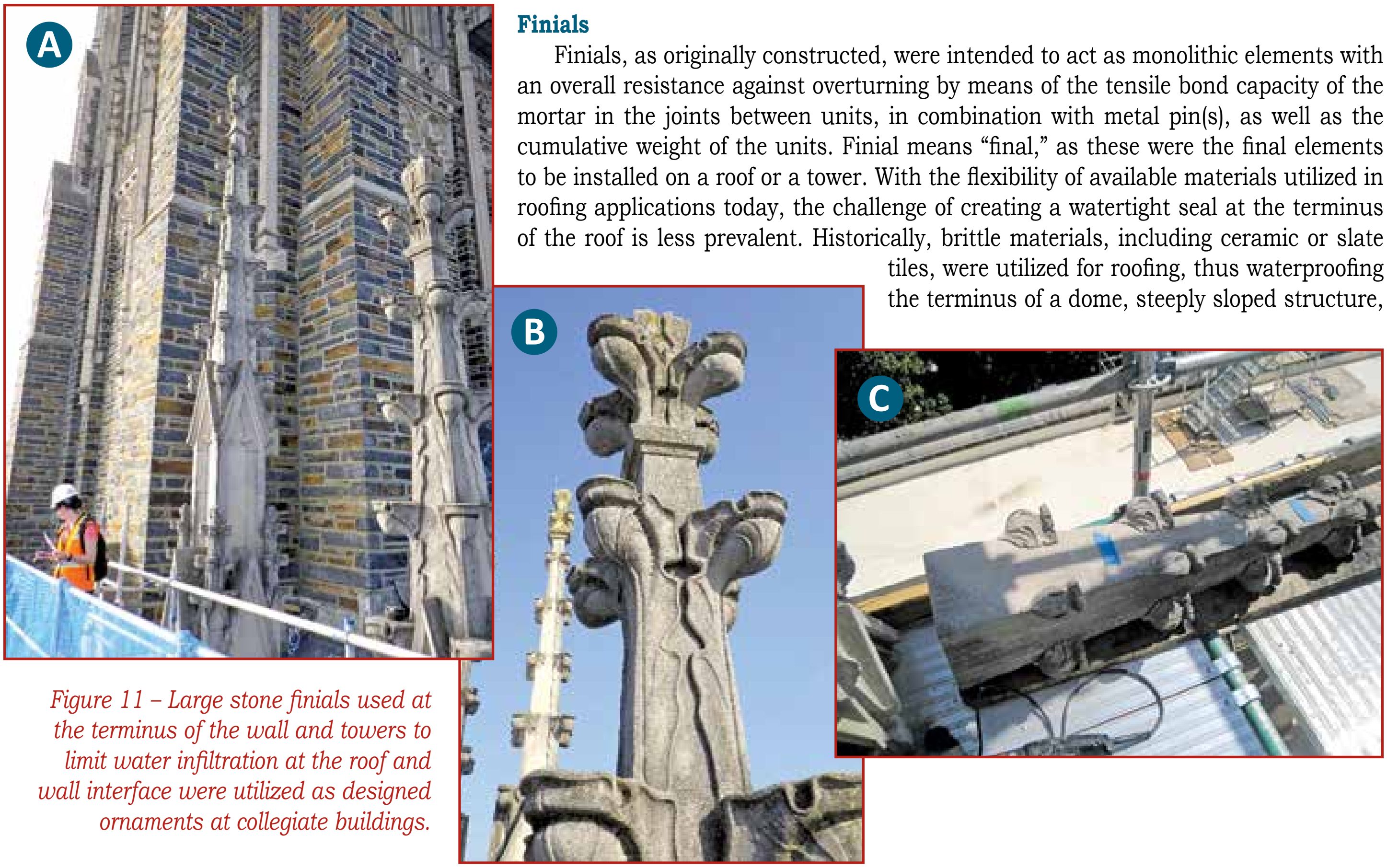


Figure 11 – Large stone finials used at the terminus of the wall and towers to limit water infiltration at the roof and wall interface were utilized as designed ornaments at collegiate buildings.

Figure 12 – Photos show the use of granite at the base of a column at a limestone-clad building (12A), and the use of more dense stone material for the gargoyle scupper (12B) as compared with the stone on the building façade. Figure 12C shows a view of a gabled parapet with use of more durable Indiana limestone at the high-exposure regions, including copings and finials, as compared with the rusticated corner quoins constructed of Illinois limestone.

or terminations at the towers was difficult, leaving an area vulnerable for water infiltration. In order to cover this location to limit water infiltration, as well as hold the tiles or masonry units in place at the terminus, large finials constructed of large monolithic stone or other masonry materials that did not require a covering to limit water infiltration were designed. An example of large stone finials utilized to cap portions of the wall at the roofing interface due to challenging detailing for limiting water infiltration at the interface is included in *Figure 11*.

Similar to cornices and water tables, the finials and balustrades were used to cap portions of the roof to limit water infiltration. In many instances, these elements—especially finials—were severely distressed due to the extreme dual exposure to wind and rain, resulting in degradation of the materials, as well as an internal structure. In the name of public safety, due the distress and the need to keep masonry elements from falling to grade, many of these finials and balustrades were removed. The removal of the finials typically was completed with little care, which often resulted in haphazard patching of the roofing system, and resulted in a new maintenance issue, thus ultimately ending in water infiltration and deterioration of the roofing materials and structure.

MATERIAL/DETAIL EXEMPLARS

Material selection in architecture is not limited to evaluating the strongest, least-expensive, or most readily available materials. Architects in the past, and continually today, explore the options to select materials based on their function, which often results in varied aesthetics. The material selection of the design is a complex process that is influenced and determined by numerous preconditions, decisions, and considerations, such as environmental and structural factors, as well as the integration of human comfort and aesthetics. The process of contemporary material selection, not unlike historic precedent, is focused on the function of the material; however, today, the focus also includes the technical properties of materials.

The local environment and the construction materials dictated many aspects of historical architectural form and ornament. While aesthetics is part of the conversation, with regard to material selection in architectural ornamentation, the understanding of durability and function were also considerations. This can be seen throughout architecture where materials that are more durable were used for the higher exposure regions, such as using granite or more dense stones at the base of a building where snow, ice, and water would accumulate, along with the application of deicing salts (*Figure 12*). Similar detailing is also often used for copings on top of parapet walls. Scale and economics are considered as part of the material selection process. Materials that are more expensive frequently were, and are, only incorporated near the base of a building. Coincidentally, in many instances, these materials are often more durable. Designers also recognized that ornamentation could be simplified to provide the same overall aesthetic the further above grade it was used.

There are often times when the design of ornamentation is related to the small details that help to shape the aesthetic of a building, such as integrating functional elements (i.e., scuppers and gargoyles) as practical yet ornamental detail into the overall architecture; or something as minor as drip edges on stone, which allows for better water shedding and less deterioration. At a larger scale, environmental factors such as sun, wind, and water become some of the ornamental details of the building façade and architectural form.

CONCLUSION

Throughout history, in most instances, designed ornamentation has served more than a mere aesthetic function. It has also been intended to improve the performance of the building from both a comfort and maintenance perspective. Many building aesthetics—particularly the ornamentation—have been utilized to offset or enhance environmental factors and have been guided by environmental factors as observed by the historical local style and precedent.

As illustrated in many of the exemplars, maintenance and repair of designed ornament and form, rather than removal, is important to limit deterioration. When this functionality is removed, portions of the exterior skin often experience more severe exposure, resulting in accelerated deterioration.

With the renewed interest in environmentally sensitive design, many of the principles discussed in this paper are being adapted and reintroduced into contemporary design. This includes mechanical systems that take into account the exterior weather conditions (i.e., operable windows, fresh air intake, etc.), sun-shielding and water-shedding façade elements, and the use of locally available sustainable materials. Furthermore, in the continued race for the tallest building title, it is critical that designers understand that geometry and massing play a major role in the developing of efficient structural solutions for these buildings.

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   > The ultimate in polite architecture will have been designed by a professional architect or one who has acted as such through some other title, such as surveyor or master mason; it will have

> been designed to follow a national or even an international fashion, style, or set of conventions, towards an aesthetically satisfying result; and aesthetic considerations will have dominated the designer's thought rather than functional demands.

As a theoretical term, the differences between the "polite" and the "vernacular" can be a matter of degree and subjective analysis. Between the extremes of the wholly vernacular and the completely polite, there are buildings that illustrate vernacular and polite content.

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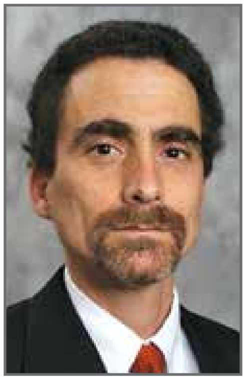
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