CHAPTER 2

THE LANGUAGE OF CLASSICAL ARCHITECTURE: FIFTEEN THINGS TO KNOW

It is common sense to use a time-tested body of knowledge to cope with present-day exigencies.
—DEMETRI PORPHYRIOS

A lifetime of experiment, observation, and reflection is not too long to master the subtleties, the refinements, and the wealth of the classical language. At the same time, a perfect knowledge of the theory alone does not guarantee good design. The aspiring classical architect should try to design as early as possible. It should be encouraging to know that good results can be achieved in a short time with a limited body of knowledge. This chapter presents the basic classical elements and the rules that control their use, so that the reader can learn to design small and simple classical buildings or portions of larger ones. Even at an early stage of the learning process, it should be possible to satisfy the expectations of a capable classical architect.

The diagrams of classical elements that follow are accurate, but they are only diagrams, intended to focus on the essentials. Do not conclude that classical architecture is crude. The geometric and proportional relationships between the parts are simple, but they are rigorous. They must be well understood to be useful. Only fundamentals are presented here. More sophisticated studies are presented in treatises, which include detailed comparative plates of the orders. By all means look at them: not only are they informative, but they also are things of beauty.

THE MODULE

There is no question that classical architecture begins and ends with the orders. Even when the orders are not visible, they are always implied. The orders must be understood and learned first because they embody the very essence of classical architecture. They can be studied sequentially, beginning with the simpler ones, the Tuscan and the Doric, then proceeding to the more complex ones, the elegant Ionic, the exuberant Corinthian, and finally the ambiguous Composite. Or it may be easier to study them concurrently. What the orders have in common is simple enough, and the differences between them reveal their distinct personalities.

The largest component of a column is the shaft, situated between the base and the capital. It is almost, but not quite, a cylindrical form. Although the proportions of the shaft have been subjected to subtle adjustments by experienced architects, an ideal ratio between the height of the shaft and its diameter has been adopted for each order. This is not an arbitrary proportion; it has been arrived at through trial and error by some of the greatest architects over centuries of experiments.

One of the reasons for a different ratio for each order is to give architects a choice. At one end of the range is the sober Tuscan and its sturdy proportions, and at the other is the refined Corinthian with its slender shaft.

The height of classical columns can vary from 10 to 200 feet. Since classical aesthetics depend largely on orderliness, it became necessary to devise a system to coordinate all the parts of a building. A basic unit was chosen for this system, independently of actual measurements, which might be metric or based on feet and inches. The unit is called the *module*, and it is always equal to half the diameter of the shaft where it is widest. This occurs at one third of its height from the bottom; the shaft is always narrower at the top, which gives the impression of a gentle bulging, or swelling, called entasis. The module coordinates the entire classical vocabulary in a self-referential system that is used at any scale.

By consensus, the height of a Tuscan shaft is equal to 14 modules, or seven times its diameter. The height of a Doric shaft is 16 modules, or eight times the diameter. The height of the Ionic is 18 modules, or nine times the diameter. The height of a Corinthian or Composite shaft is 20 modules, or ten times the diameter.

ENTASIS

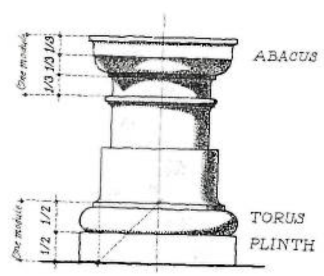
Although subtle, entasis is critical. Only the lower third of the shaft is a true cylinder; the upper two thirds taper upward in an almost imperceptible curve reducing the diameter to 5/6 of its largest dimension. In the Ionic, Corinthian, and Composite, tapering occurs in the lower third as well, but downwards, and to a less pronounced extent. In all cases, the shaft is wider at the bottom than at the top.

Why entasis? Why such a refinement? As a metaphor for the human form, a classical column must have something of the organic in it. Without entasis, a shaft could not be said truly to have a beginning, a middle and an end. Entasis is a formal acknowledgment by the shaft of the base and the capital and of the load-bearing role of the column. Although essential, entasis must be barely visible (fig. 2.1). Excessive entasis looks worse than none (fig. 2.2). Precise methods for drawing the entasis are included in most treatises.

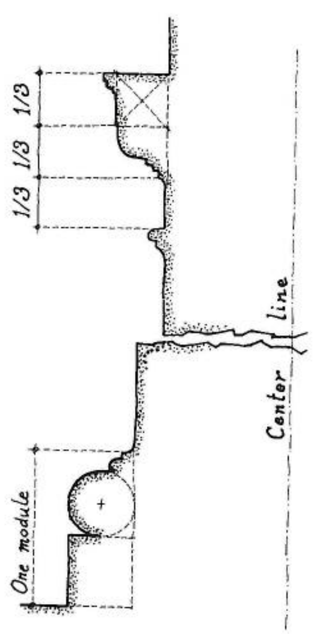
2.1. Corner column in the Doric order. Student exercise at the Ecole des Beaux-Arts, 1950s.

2.2. Columns without entasis on a newer building in Boston.

2.3. Fluted Ionic columns at Rosehill Mansion, Geneva, New York, c. 1835. Architect unknown.



2.4. Tuscan order: base and capital.



2.5. Roman doric order: base and capital shown in profile; compare with fig. 2.4.

BASE AND CAPITAL

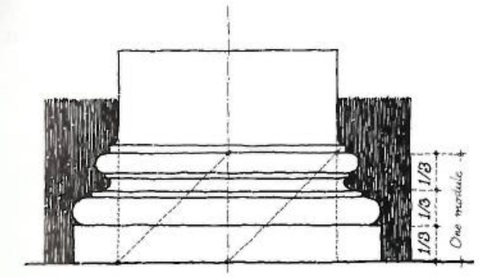
Columns are either structural or suggestive of structural support. It is not enough for a structure to be reliable; it must also look reassuring. The base and the capital are the beginning and the end of the column, and their main function is to negotiate a harmonious transition between the vertical shaft and the horizontal elements above and below.

Bases are wider than they are high, as if they were half-crushed under the weight of the shaft. Whatever their design, they measure one module in height. Capitals also are one module in height, with the exception of the Corinthian and the Composite, which look like an efflorescence and express upward thrust. This is consistent with the more slender proportions of the shaft, which suggests a stem. Elongation is further reinforced by the vertical lines of fluting (fig. 2.3), more common in the Corinthian than in the other orders, and never found in the Tuscan.

Base and capital also negotiate the transition between the geometry of the plan, most often based on a rectangular grid, and the section of the shaft, which is a circle. To reconcile these geometries, square elements are found at the top and bottom of the complete column. The base begins with the square *plinth*, and the capital ends with another square, the *abacus*. The parts between plinth and abacus are all circular in section.

On the Tuscan order, the base is divided into two parts of nearly equal height, the plinth and the *torus*, which is circular in plan. The capital, more elaborate than the base, is made of three parts of equal height (fig. 2.4).

The Tuscan order is a Roman derivation of the original Doric invented by the Greeks, with which no base was used at all, as can be seen at the Parthenon, for example. The base of the Roman Tuscan may be omitted to emphasize strength and simplicity. The Roman Doric order is very similar to the Roman Tuscan. The base and capital are shown in figure 2.5.



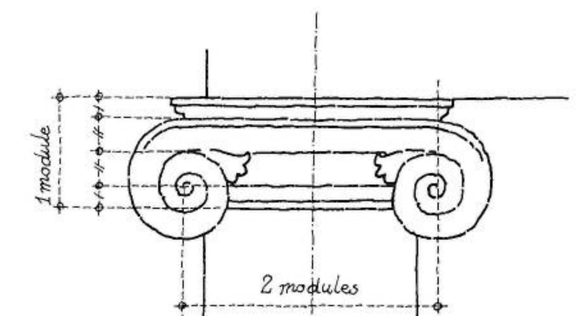
2.6. Attic base.

2.7. Attic base adapted for use as a pedestal for a bust.

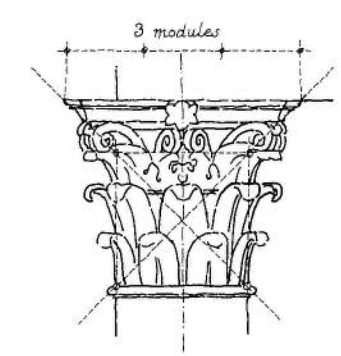
There are only two essential designs for the bases of all the orders: the Doric base and the Attic base, which can be used with both the Ionic and Corinthian orders and is often substituted for the more complex and varied bases specifically designed for them. The Attic design has the advantages of clarity and simplicity (fig. 2.6). There is something so satisfying in the rhythmic alternation of curved and straight lines in its profile that the Attic base has been adapted for other purposes. With some changes in the proportions but none in the basic design, it has, for instance, become a nearly perfect pedestal for small busts or heads displayed indoors (fig. 2.7).

Although the Ionic and Corinthian capitals are exceptionally rich and beautiful, their formal structure is so simple that it can be captured in diagrams. While both orders mark the transition from the vertical to the horizontal with a flourish, the Ionic emphasizes the horizontal. The height of the Ionic capital (fig. 2.8) is one module, not including the elegant spiral volutes, and the overall width is almost three modules. The distance between the "eyes" of the volutes is two modules, and the ratio between the width of a volute and the distance between a pair is 3 : 5.

The main thrust of the Corinthian is vertical, which makes it appear taller than it is wide. The Corinthian capital is three modules wide at the top, and its height is determined by drawing lines at a 45-degree angle from the top to the shaft (fig. 2.9).

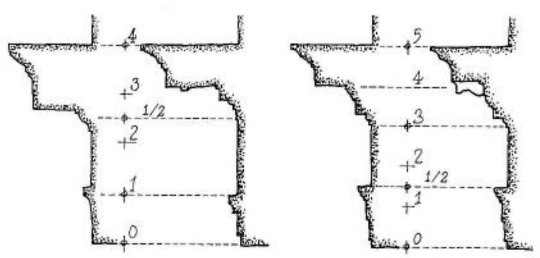


2.8. An approximate method for drawing the Ionic capital.

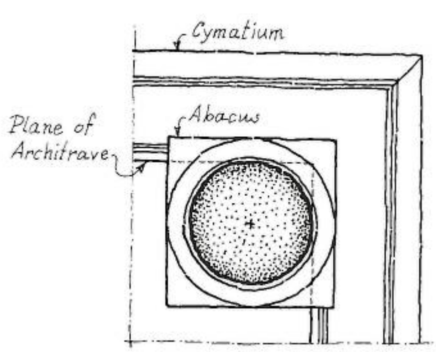


2.9. Diagram of a Corinthian capital.

2.10. Ionic entablature at the Château de Bénouville, Normandy, 1768–77. Claude Nicolas Ledoux.



2.11. Profiles of different entablatures and their proportional subdivisions. From left to right, Tuscan, Doric, Ionic, and Corinthian.



2.12. Horizontal section through a Tuscan column, looking up: shaft and architrave are perfectly aligned.

ENTABLATURE

The entablature (fig. 2.10) completes an order and is designed especially for it. Its height is always equal to a quarter of the column height. In spite of its major role and its considerable mass, the entablature is often overlooked by inexperienced designers.

Like the column, the entablature is composed of three parts, the architrave, the frieze, and the cornice. The architrave acts as a lintel, sitting directly on the capitals and spanning the intervals between them, and its structural function is expressed by horizontal striations. The uppermost element of the entablature is the cornice, which caps the order and projects forward to protect it. The third element, the frieze, is inserted between the architrave and the cornice. It is probably there that transverse beams rested on the lintels of early buildings. Since the frieze is a "soft" element between two "hard" ones, it is sometimes omitted, with the result that the entablature becomes slimmer. The frieze may also be made more assertive by having it bulge out (in which case it is called a *pulvinated* frieze) or by having it carry rich ornamentation.

Compare the profiles of the entablatures (fig. 2.11), which determine the character of each order. Moving from Tuscan to Corinthian, the height of the architrave increases as the height of the cornice decreases. There is a graphic method to obtain the relative height of the elements. Divide the entablature of the Tuscan and Doric into four parts; one part becomes the architrave while the rest is divided equally between the frieze and the cornice. For the Ionic and the Corinthian, divide the entablature in five parts; the cornice will take two parts. The frieze and the architrave will divide the rest equally between them.

Columns are always rigorously aligned with the face of the frieze and architrave. In other words, if this plane were expanded, it would be tangent to the upper part of the columns (fig. 2.12).

An entablature is always supported at a corner; it must never be cantilevered. This is an absolute rule. An entablature may move forward and backward, but it must always be accompanied by an element on which it sits squarely, whether it be a column, a pilaster or even a wall. At the Chiesa Nuova in Rome (fig. 2.13), the entablature moves forward from the wall to the top of pilasters and then back again to the wall. An entablature directly supported by a wall must project slightly outward so that a shadow line indicates where the wall ends and the entablature begins.

The design of corners gives classical architects the opportunity for a wide range of inventive solutions—all within the rules. Looking up and down a corner of the palace at Versailles (fig. 2.14), the diversity of solutions is such that the eye is always challenged but never confused.

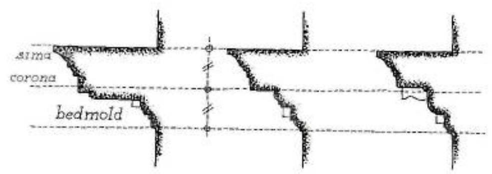
Corners should be seen as "solid" in contrast to "soft" facades. In masonry buildings, corners must give an impression of strength while the facades, which are penetrated by many openings, will be more inviting. Modern architects have often done the reverse in order to dematerialize corners. In many of his buildings, however, Mies van der Rohe used steel and glass in a classical way (fig. 2.15). It should not be forgotten that the most admired architects of the twentieth century were very much aware of the classical language and classical design solutions.

The cornice (fig. 2.16) is the part of the entablature that most requires close attention. The cornice projects from the vertical plane of the frieze and architrave and is therefore highly visible. Like the column and the entablature, the cornice is divided in three parts. The middle part, or *corona*, is a bare, vertical surface exposed to full light. When the sun is out, it casts a significant shadow. The *sima* above and the *bedmold* below the corona are both angled and are more or less in the shade. In the Ionic,

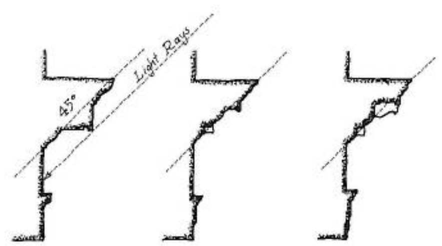
2.13. Chiesa Nuova, Rome, begun in 1575 after a design of Giovanni Battista Soria. An entablature moves back and forth with its support.

2.14. Royal palace at Versailles, begun 1661. Louis Le Vau and J. H. Mansart. A corner emphasized through iteration.

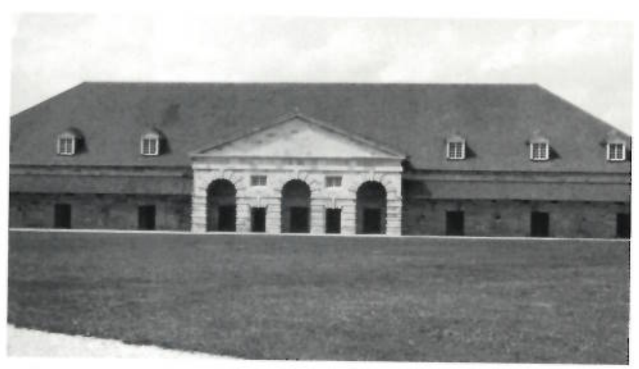
2.15. A corner of the Museum of Fine Arts, Houston, 1954 and 1974. Mies van der Rohe.



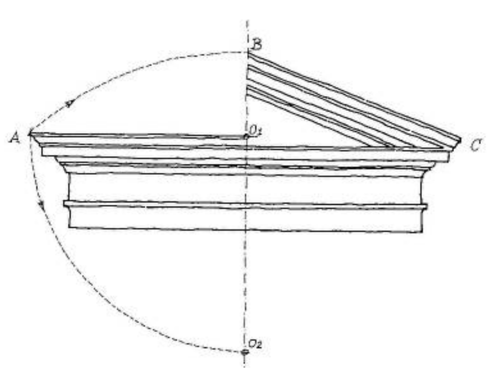
2.16. From left to right, the profiles of the Doric, Ionic, and Corinthian cornices.



2.17. Determining the projection of the cornice from the wall. From left to right, the profiles of the Tuscan, Ionic, and Corinthian entablatures, shown in cross section.



2.18. Processing plant at the Royal Saltworks, Arc-et-Senans, France, 1775–79. Claude Nicholas Ledoux. Used here without columns, a pediment glorifies the center of a facade.



2.19. Method for determining the slope of a pediment. On the left side, the entablature used as a starting point; on the right, the pediment generated from the entablature.

the projecting edge divides the cornice in half. The dividing line is lower in the Doric and higher in the Corinthian, making the latter more delicate and giving the former a heavier, stronger aspect.

The projection of the cornice is determined by a 45-degree angle from the top of the frieze (fig. 2.17). R. A. Cordingley, in his introduction to Normand's *Parallel of the Orders of Architecture*, suggests a projection of 3/4 of the module for the Tuscan, Ionic, and Corinthian, but architects tend to prefer a graphic method over a mathematical formula.

The designers of canonical classical forms paid great attention to profiles, that is, the forms in space seen in elevation or in section. Unfortunately, the full effect of these forms is not conveyed by line drawings. Perspective drawings are more successful, but they are not accurate; dimensions cannot be taken from them. A more effective method is to use a light source and draw the resulting shading. This technique was used empirically until the eighteenth-century geometer Gaspard Monge invented a scientific method to draw shading. His method allows a trained eye to derive accurate and complete information and an untrained eye to perceive the third dimension. Without shading, planes and curved surfaces would appear equally flat in a picture.

Monge proposed the angle of the diagonal of a cube, or 36 degrees, 16 minutes, which is seen at 45 degrees in plan as well as in elevation. This convention confirms the significance of the heavy shadow cast by the Tuscan cornice, compared with that of the Ionic or the Corinthian cornice.

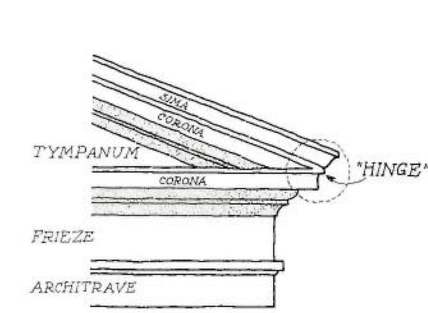
PEDIMENT

A pediment interrupts the entablature to emphasize a special place, usually at the center of a facade (fig. 2.18). The triangular shape reinforces the vertical thrust already suggested by the columns or piers underneath. Since the dynamic effect is powerful, the pediment should be used with moderation and only where appropriate.

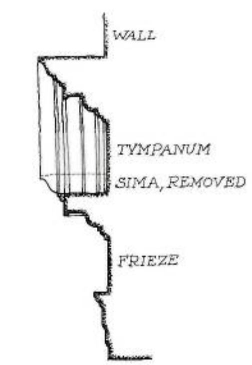
The slope of a pediment can be determined with a simple geometric operation (fig. 2.19). Place the point of a compass on 0_1, where the axis intersects the top line of the cornice. Trace a curve from A, at the extremity of the cornice, to 0_2 on the axis. Place the compass on 0_2 and trace a curve from A to B. This determines the apex of the pediment. The slope of the pediment is obtained by joining B to A or C.

The profile of the existing cornice is not affected by the introduction of a pediment, but the sima is now sloping to form the top member of the pediment. In the process, the fillet underneath is duplicated so that it retains its horizontal position while its clone follows the sima in its new sloping position. The meeting point of the two fillets is the hinge between the horizontal cornice and the new cornice of the pediment (fig. 2.20). Along with the sima and the fillet, the corona and the bedmold underneath are duplicated so that there are now two cornices. But in the end, the sima belongs with the pediment, not with the horizontal cornice (fig. 2.21).

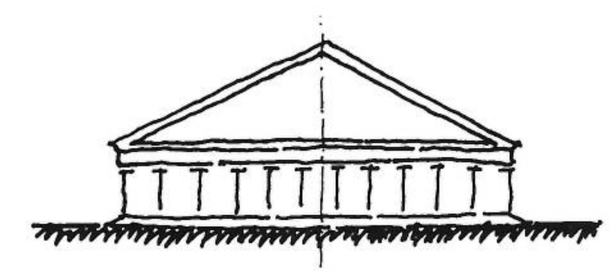
The relationship between pediment and entablature is described here in such detail because it is a remarkably ingenious design solution. Since the correct relationship between pediment and entablature is constant for all the orders, it is important to understand it well. The slope of a pediment should never be increased. It can and should be reduced when the width of a facade would require a pediment of great height, since its mass would appear to crush the building underneath (fig. 2.22). A variant is the curved, or segmental, pediment (fig. 2.19). Instead of joining A to B with a straight line, use the curve shown as a dotted line between the same two points (fig. 2.23).



2.20. Cornice and pediment articulated around a hinge point. The stippled area identifies the original bedmold and its clone.

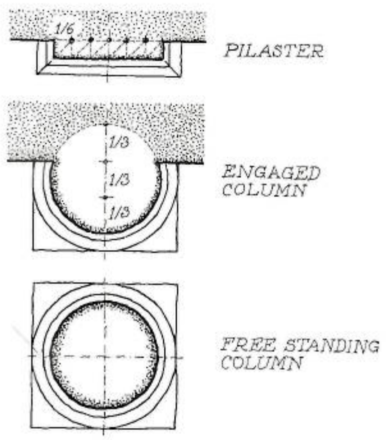


2.21. Cross section of an entablature carrying a pediment. The sima has been eliminated from the horizontal cornice to form the cap of the pediment.



2.22. A pediment that is too large will overwhelm a building by its excessive mass.

2.23. The Brick Market, Newport, Rhode Island, 1761–72. Peter Harrison. Curved and straight (triangular) pediments alternate here.



2.24. The three column variations: freestanding, engaged in the wall, or pilaster applied to the wall.

2.25. St. Peter's Square, Rome, begun 1656. Bernini used 280 columns, each 50 feet high, to unify a huge and complex urban space. The architect combined Doric columns with an Ionic entablature.

2.26. Colonnaded galleries of the Palazzo della Ragione, Vicenza, begun in 1549. Andrea Palladio.

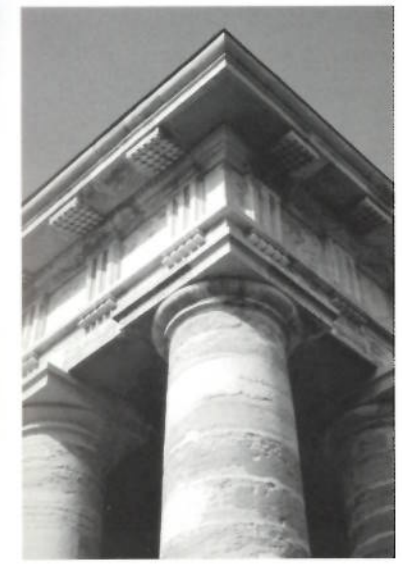
VARIATIONS ON THE COLUMN

Of the three forms the column might assume, the freestanding one is the most familiar. The other two are the engaged column and the pilaster. With an engaged column (fig. 2.24), the proportion of exposed to hidden is important. Revealing only half of the column gives an impression of uncertainty, as if the column could not decide whether to be part of the wall or not. When two thirds are exposed, the column nearly appears to be whole, which is more satisfying. The wall in which the column is engaged should be thicker than the column to avoid the impression that the load is carried by the column rather than the wall.

With a pilaster, the profiles of shaft, base, and capital remain the same, but the horizontal curves are replaced with straight lines so that all horizontal cross sections will be rectangular. The normal ratio between the width of the pilaster and its depth is 1 : 6. This is all that is needed since a pilaster is a mere suggestion of a column. For the same reason, entasis is unnecessary and the width remains constant from top to bottom.

Columns, freestanding, engaged, or in the form of pilasters, may be used together as long as they are of the same order, have the same height, and are rigorously aligned. Their common purpose is to ensure regularity and unity in a building, or a portion of a building. It would defeat that purpose to alter a colonnade beyond these restrictions (fig. 2.25).

Combining two sets of columns of different heights in the same composition presents a number of difficulties that have been successfully overcome in the past. Two famous examples are Michelangelo's twin palaces on the Campidoglio in Rome, and Palladio's Palazzo della Ragione, also known as the Basilica, in Vicenza (fig. 2.26). The latter is the more classical of the two. When two sets of columns alternate, the height of one set should not be half of the other. The best relationship is two to three, which suggests a closer kinship between the two sets.



2.27. A corner of the entry building at the Royal Saltworks. In the Doric order, the spacing of columns is determined by mutules, triglyphs, and metopes or by denticles.

2.28. Touro Synagogue, Newport, Rhode Island, c. 1763. Peter Harrison. An Ionic porch showing the relationship of Ionic capitals and modillions. The modified Ionic capitals are of the "Scamozzi" type. Note how the rear columns are engaged in the back wall.

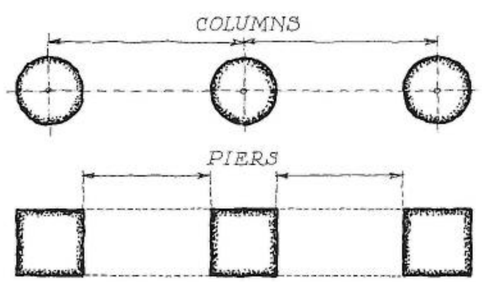
COLONNADES

To say that a colonnade is a row of columns is true, but it is an incomplete description, for colonnades come in many forms. Double, triple, or quadruple rows of columns produce very different effects. Columns may be paired off; they may alternate with piers or be placed in front of walls; columns may be joined by arches as *arcuated* colonnades or by lintels as *trabeated* colonnades; arches can also alternate with lintels. As noted earlier, the purpose of a colonnade is to regularize and dignify a wall, a building, or an outdoor room. That is why a colonnade must consist of identical columns of constant height or, at the most, of two sizes, and the intervals between them must obey clear rules.

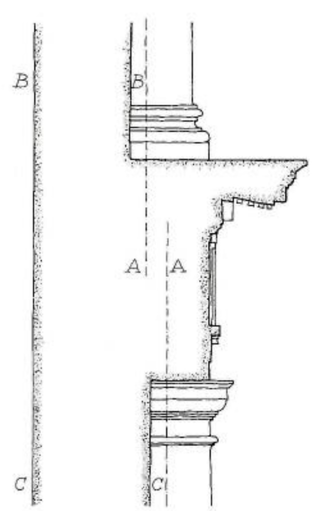
How far should the columns be from one another in a colonnade? Architects and scholars have been arguing for centuries over the ideal spacing, and they have often disagreed. *Intercolumniation* is the formal term for the subject. What is certain is that columns may not be so close that their capitals interfere with one another. As for the maximum distance, a square bay is most likely to be structurally unsound, and it will look precarious. A ratio of 1 : 2 (the equivalent of two superposed squares) looks reassuring. So does a narrower bay. Paired columns alternating with wider bays introduce variety in a colonnade without making a disorderly impression.

Other restrictions make the discussion of ideal proportions somewhat irrelevant. In the Doric order, the spacing of columns is contingent upon brackets, called *mutules*, situated under the corona. Mutules match the *triglyphs*, which alternate with *metopes* in the frieze (fig. 2.27). Triglyphs and mutules are one module wide and metopes are $1\frac{1}{2}$ module square. Since triglyphs are centered on columns, the options are limited to $2\frac{1}{2}$, 5, or $7\frac{1}{2}$ modules. With the Ionic and the Corinthian, spacing depends on the *modillions*, another type of bracket, also centered on columns (fig. 2.28). The Ionic order does enjoy more flexibility when the elements that regulate

2.29. The double colonnade at the Grand Trianon, Versailles, 1687–90. Robert de Cotte for J. H. Mansart.



2.30. Measurement of bay widths when points of support are columns or piers.



2.31. Two tiers of engaged columns. The base of an upper order must be in the same fictitious vertical plane as the entablature underneath. This precludes the column axes from being aligned (A-A.) As a consequence, the wall must be thicker in the lower tier (C-C) than in the upper one (B-B).

the spacing of columns are not modillions but *denticles*, little cubes found under the corona.

In order to sustain the regularity of the colonnade, the spacing of columns must be either constant, as in A-A-A, or consist of two different alternating widths, as in A-B-A-B. The colonnade designed at the suggestion of Le Nôtre for the Grand Trianon in Versailles is an example of the latter (fig. 2.29). Any further subdivision would result in confusion and unsettle the observer.

Measurements between columns are taken from axis to axis because the curved surface of the columns combined with entasis makes any other measurement meaningless. Only where piers are used instead of columns do the intervals between structural supports have a definite form that can be accurately measured (fig. 2.30).

SUPERPOSING THE ORDERS

The rules controlling the vertical relationship of columns are simple. There are a few cases where the same order is used in a two-tier design but superposition usually involves different orders. The sequence, sensibly enough, always places a heavier order under a more slender one.

As noted, it is essential that the front plane of an entablature, i.e., the plane of architrave and frieze, be perfectly aligned with the upper part of the shaft (fig. 2.31). This rule also applies to the base of an upper order and the entablature of the order underneath. Since a base is wider than a shaft, the entablatures of superposed orders cannot be in the same plane, and the order on top will recede substantially from the one underneath. If this occurs two or three times, the wall against which the orders are applied will be considerably thicker at the base than at the top. But that is logical since more material is required at the base to support the compounded weight of the building.

The rule of decreasing section was also applied by Mies van der Rohe in some of his high-rise buildings, even though there are other ways to

2.32. Apartment building, Nun's Island, near Montreal, 1969. Mies van der Rohe. The section of the steel supports is reduced above the third regular story and again above the eighth story.

2.33. The central bay of the chateau at Anet, west of Paris, 1455–1555. Philibert Delorme. Re-erected at the Ecole des Beaux-Arts, Paris, 1804. An elegant sequence of superposed Doric, Ionic, and Corinthian twin columns. Although receding towards the wall, the axes of superposed columns remain in the same vertical plane perpendicular to the wall.

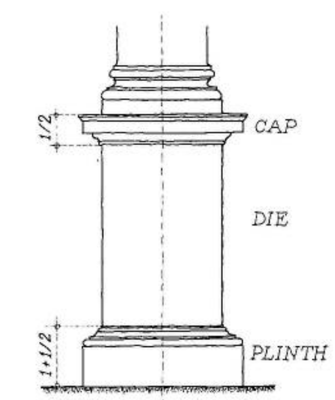
solve the problem of compounded weight in steel or concrete structures (fig. 2.32). Mies may have done this for visual effect, in homage to the classical tradition that he knew well.

Another important issue is the relative height of superposed columns. Should their height be equal, shorter, or taller? J. N. L. Durand, in his *Leçons d'Architecture*, stipulates that, if the columns are the same order, those in the upper tier must be shorter. If the columns are different orders, they may be the same height. But his main concern is with the diameters: the maximum diameter of an upper column must be equal to or less than the minimum diameter of the column below (fig. 2.33).

2.34. The triumphal arch at the Tuileries Gardens, formerly the gate to the Royal Palace, Paris, 1806–8. Charles Percier and Pierre Fontaine.

PEDESTAL

Pedestals are placed under columns to increase their vertical reach without increasing their bulk. They may be considered an integral part of the order (fig. 2.34). The height of the pedestal is one-third of that of a column, regardless of the order (fig. 2.35). The width of the die is deter-



2.35. A pedestal supporting a column.

2.36. Villa Rotonda, near Vicenza, 1566. Andrea Palladio. One of eight simplified pedestals, each supporting a statue. What appears to be a pedestal stretches out to form the base of the entire building. The design of the attic story resembles that of a pedestal; it can be glimpsed above the entablature.

2.37. Design variations on the pedestal motif at the Tuileries, Paris.

mined by the base of the column; its height may be reduced but not increased. The cap is a simplified cornice, one half module in height; the plinth is a module and a half in height.

A pedestal may be expanded laterally when it is placed under twin columns (fig. 2.33). As noted earlier, a pedestal becomes a *stylobate* when stretched out to serve as the base of an entire building and a *dado* when defining an interior wall. Another application of the extended pedestal is the *attic*, a plain upper story that terminates a building above an entablature. Palladio used the pedestal motif as a base for the entire building in his design for the Villa Rotonda (fig. 2.36), and again for the upper story of the main block.

The shape of a pedestal can be given to many elements—chimneys, for example. Freestanding pedestals can animate gardens, and they are often used to define outdoor spaces (fig. 2.37).

BALUSTRADES AND PARAPETS

Balustrades are familiar because of their distinctive balusters, but a *parapet* is a solid form of balustrade, and its design is very similar. A parapet is, in fact, a stretched out pedestal. Parapets are used in place of a very long balustrade (fig. 2.38). This may be on a ridge in a garden, where it would be extravagant to line up hundreds of balusters with so many other elements competing for visual interest. In either form, the frame is made of a die and a cap stretched between consecutive pedestals, which retain their block-like shape. Balusters are inserted between the die and the cap, and the latter forms the handrail.

The width of the balusters and the space between them should be approximately equal. Increasing the distance between balusters inevitably results in an unpleasant, weak appearance. A row of more than twelve balusters looks relentless; to relieve the monotony, residual dice are inserted at regular intervals (fig. 2.39). These do not affect the continuity of the handrail, and no ornaments should be placed on them. Sometimes half-balusters are placed against dice and pedestals at each end of a row. A long stretch of parapet should be broken up with pedestals at regular intervals. To emphasize a rhythmic effect, ornaments such as urns, vases, or even statues can be placed on the pedestals.

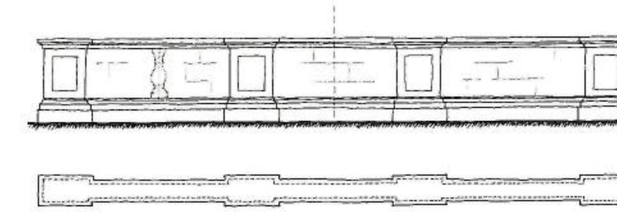
Balustrades are ornamental design elements that should only be used on buildings or in their vicinity. Their practical use is to prevent falls, but they are also used on inaccessible roofs to soften the transition between the solid mass of the building and the sky above.

The baluster, an invention of the Renaissance, is an interesting motif because it is seen at close range and can be touched with the hand. Although there are many slight variations, there are constants (figs. 2.40, 2.41). The height of a baluster is three times the width, measured at its greatest, in a, b, and c. This dimension also controls the thickness of the residual die. The width of the baluster is reduced by half in three places, d, e, and f, where the baluster is at its most narrow.

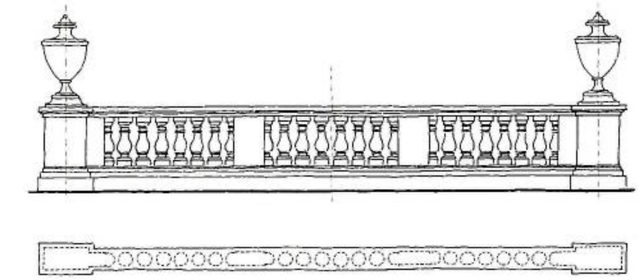
The handrail is about a foot wide, or a third of the balustrade's height on the upside (g). It is logical to increase the height of a balustrade on the downside (h), but no specific ratio can be given because it depends on the circumstance.

We have seen that the width of a baluster varies between one and two. If we divide these extremes in two and four parts respectively, six parts give us the depth of both die and handrail. Eight parts give us the maximum depth of the pedestal at the level of plinth and cap.

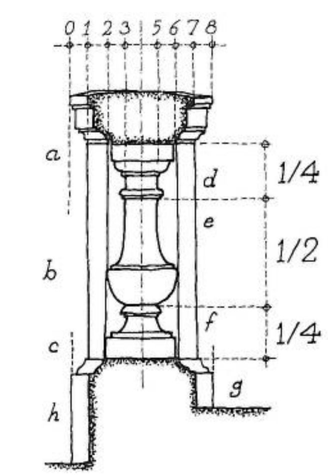
When a balustrade is used between columns on pedestals, the height of the pedestals must conform to that of the balustrade, even if that violates the rule that prescribes a height of one third of a column for the pedestal (fig. 2.42).



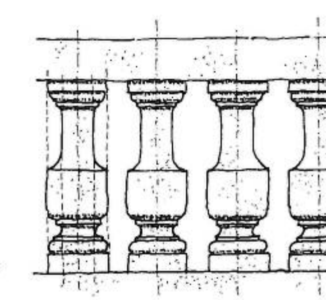
2.38. Plan and elevation of a parapet. Cap and plinth are stretched from one pedestal to the next. A thin wall replaces balusters.



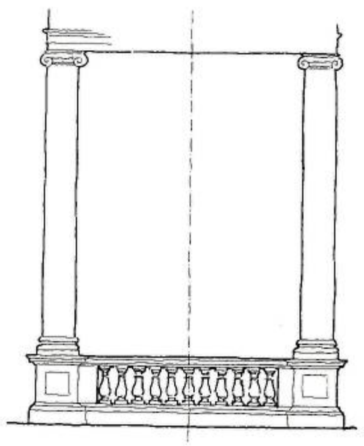
2.39. Plan and elevation of a balustrade. Residual dice are interspersed at regular intervals for visual relief and stability.



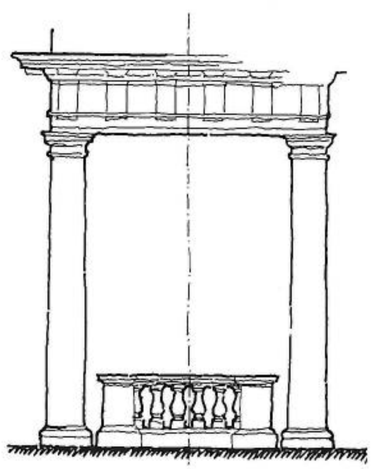
2.40. Cross section of a balustrade, showing a typical baluster.



2.41. Seventeenth-century balustrade at the chateau of Bussy-Rabutin in Burgundy. The horizontal cross section of the balusters is square from top to bottom.



2.42. If a balustrade is necessary in a colonnade, the height of the pedestals is determined by the height of the balustrade.



2.43. A balustrade should nearly fill the space between columns, but it must not touch them.

2.44. Town house, Avenue Gabriel, Paris, 1780. Lemoine de Couzon. Unobtrusive metal guardrails are appropriate on the three balconies added at the second story at a later date. Metal brackets also support the thin stone slabs.

Since columns are the preeminent classical element, they should stand in proud isolation. If pedestals cannot be used in a colonnade where a balustrade is necessary, there must be no actual contact between the two elements. Each section of balustrade must be complete in itself between columns; in other words, it must begin and end with a pedestal. The space between balustrade and columns may be narrow, but it is essential that there be one (fig. 2.43). In cases where such a treatment would seem heavy-handed, a delicate metal guardrail may be substituted for the heavier stone balustrade; if it touches the columns, it will hardly be noticeable. This solution was frequent in the decades around 1800 (fig. 2.44).

OPENINGS IN WALLS

So many classical doors and windows are in the proportion of 1 : 2 that the format of two superposed squares can be called the fundamental classical opening. The reason for this ubiquitous proportion is that it combines simplicity and clarity with the ideal frame for a human being (fig. 2.45).

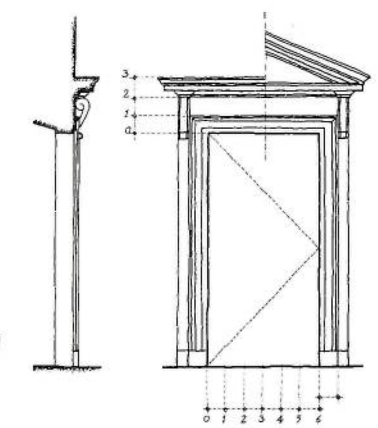
The practical purpose of doors is entry and egress, but they also present an opportunity to celebrate human beings that classical architects have seized with relish. The Philadelphia architect Alvin Holm summed it up when he declared that everyone who walks through a classical door feels like a hero. Many beautiful classical facades rely on nothing but the happy effects of proportions in their openings (fig. 2.46).

Since openings are perceived as pictures, it is natural to surround them with frames. Frames add to the beauty of doors and windows and to the significance of facades. The typical frame (fig. 2.47) is adapted from the entablature design; depending on the degree of refinement intended, a frame includes one or more parts of a diminutive entablature. A simple frame consists of an architrave wrapped around the four sides of a window or three sides of a door. In more elaborate designs, a cornice is added above, directly on top of the architrave or separated from it by a frieze. The frieze might be richly ornamented or consist of the bare wall surface running between the architrave and a "floating" cornice above. A good proportion for the width of the architrave is 1/6 the width of the opening. The same dimension may be given to the frieze and to the cornice if they are present. A pediment may be added to the cornice, and its form may be triangular, segmental, or "broken." The latter creates a fine setting for a bust or other precious ornament. This is a valid approach for both exterior and interior walls.

An opening may be enhanced by adding a pair of *consoles* under the cornice, which must be lengthened if it is to sit squarely on them. Consoles are narrower than the architrave (fig. 2.48). It is indeed a rare classical building that does not include openings in the 1 : 2 proportion, but classical openings come in other proportions, usually decreasing in height, and possibly in width, as they are further removed from the piano nobile (see fig. 1.46).

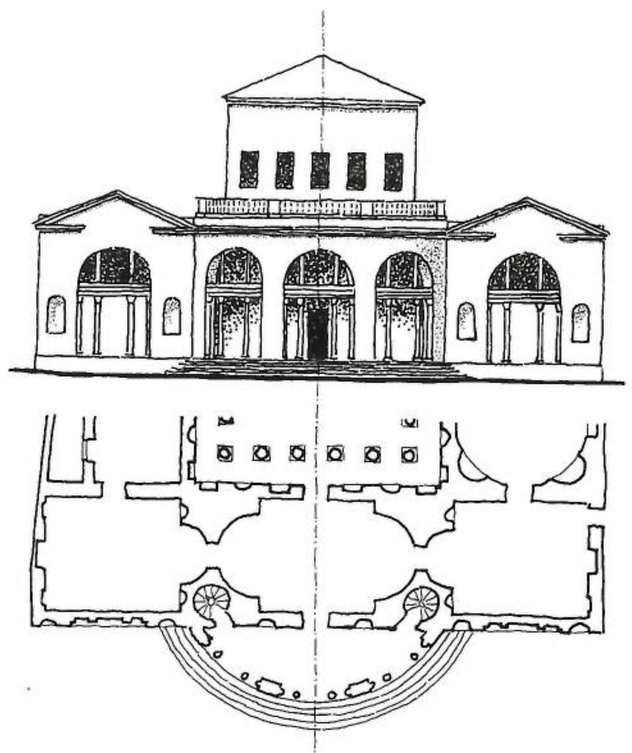
2.45. A young man framed by a double-square doorway in an early nineteenth-century French house.

2.46. The elegant windows at the Chateau de Bénouville are a study in classical restraint.

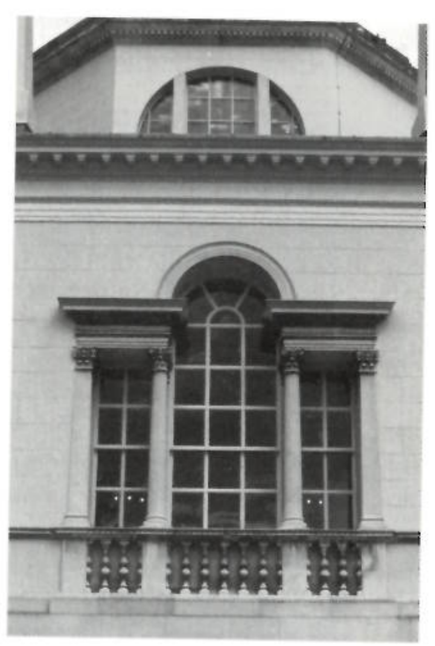


2.47. The frame of a canonical opening.

2.48. One of four pairs of windows on the main block of the Villa Rotonda. Note the consoles.



2.49. Assembly Rooms in York, 1730. Lord Burlington. Thermal windows let light into the building. The columns underneath are purely ornamental, and the curved wall in the center is a screen.



2.50. Chiswick House, near London, 1725–29. Lord Burlington with William Kent. Palladian window with a thermal window above in the drum.

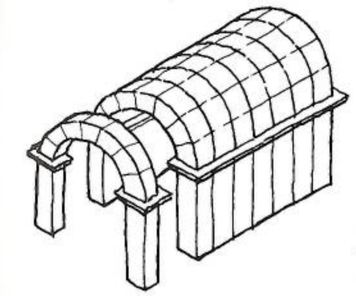
Circular windows, or *oculi*, have their place in the classical vocabulary. Two other designs must be mentioned for their significance and striking appearance. One is called the thermal window because it made its first appearance in Roman baths (fig. 2.49). It has the advantage of admitting light into a room without affecting the lower part of the wall. The other is the Palladian window, which consists of a three-light opening with the middle one round-headed and wider than the lateral ones (fig. 2.50). It is spectacular and should be used sparingly.

ARCHES AND VAULTS

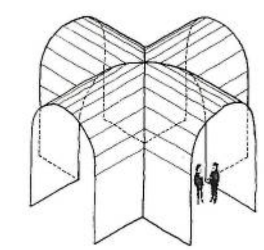
Throughout history, the challenge of covering enclosed spaces has been met in a variety of ways. A wall could be built relatively easily by piling stone upon stone, but spanning a large space required ingenuity, especially when the width of the space exceeded the length of available timber. The answer was the arch and then the vault, brilliant and paradoxical inventions that make use of small objects—bricks or stones—to cover large spaces.

A vault can be made by placing a series of identical arches side by side (fig. 2.51). Arches and vaults can assume many shapes, but classical builders have favored pure geometric forms. Usually, the formal vocabulary is limited to the straight line with the "flat arch" and the semicircle with the *barrel vault*. A number of barrel vaults intersecting one another at right angles can cover a series of square or rectangular spaces. Four supports are required for each unit but a support can serve up to four vaults. This type of vaulting is called *cross vaulting* (figs. 2.52, 2.53).

Vaults transmit considerable loads to their supports, but we perceive them in an entirely different way: they seem to "soar." In spite of their simplicity, or more probably because of it, barrel vaults and cross vaults have produced



2.51. Diagram of a semicircular arch and a barrel vault.



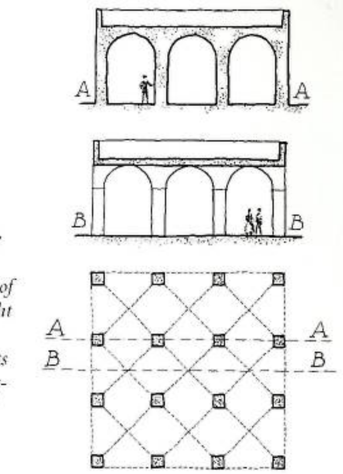
2.52. Two intersecting barrel vaults create a configuration called a cross vault.

spectacular results (fig. 2.54). Elliptical vaults take less vertical space, but the lateral stress on the walls is enormous (fig. 2.55). There are more complex vaults, but the simple ones described here can satisfy many design problems.

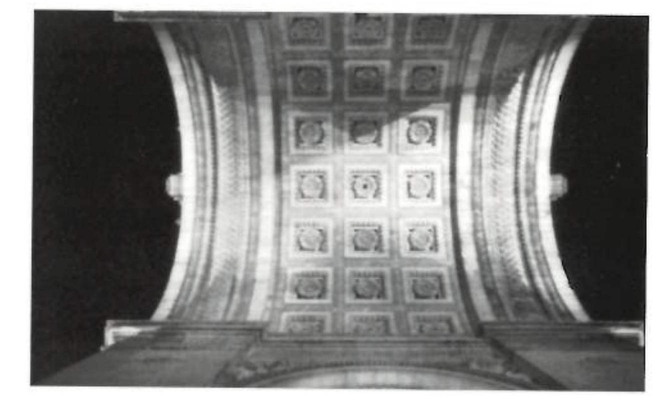
THE DOME

The dynamics of spaces defined by barrel vaults and cross vaults can be said to be mainly horizontal. A dome, on the other hand, creates a vertical pull: we tend to stop and look up when we enter a domed room. Many domes cover a square space or, more accurately, a cubic space. The reconciliation of the two forms presents an interesting problem which, in classical architecture, is usually solved as follows:

Consider a cube surmounted by a half-sphere. The diameter is such that the sphere is in contact with the four upper corners ABCD of

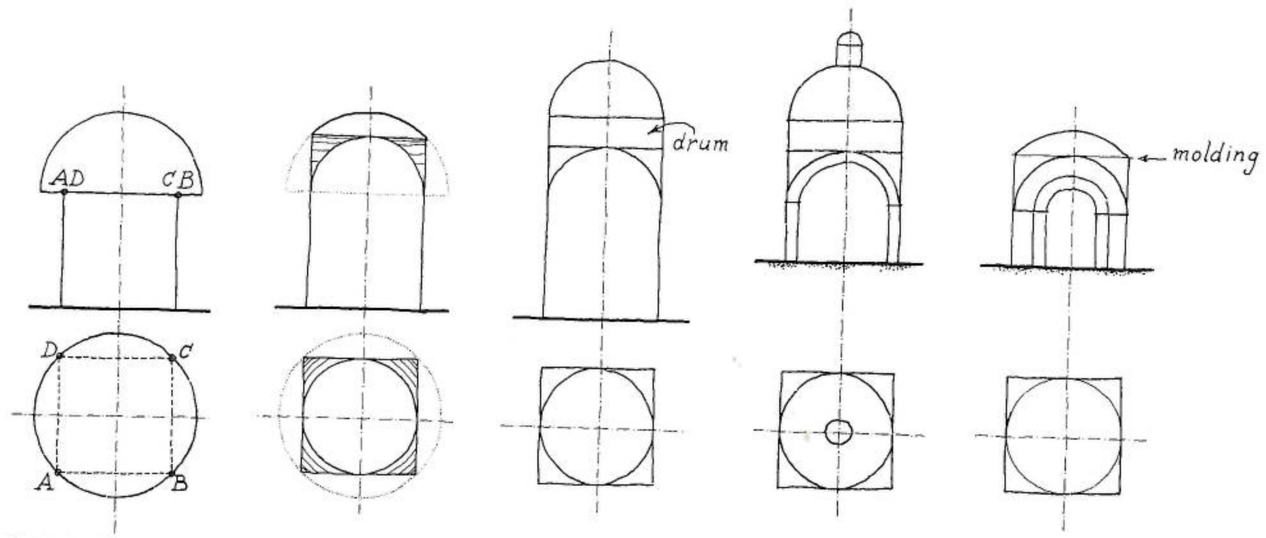


2.53. Plan and cross sections of nine squares covered by cross vaults. The vaults are formed by the intersection of three barrel vaults running left to right and three others running front to back. The six intersecting barrel vaults rest on sixteen supports. The cross section A-A is drawn through a row of piers and the cross section B-B is drawn between two rows of piers.



2.54. Arc de Triomphe, Paris, begun in 1806. J. F. T. Chalgrin. Barrel vault.

2.55. Panthéon, Paris, 1764. Jacques-Germain Soufflot. An elliptical vault with penetrations in the crypt.



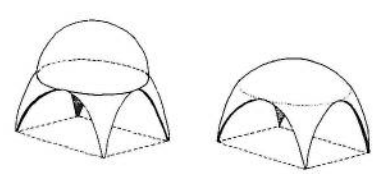
2.56a. A cube with half a sphere resting on it at four points ABCD.

2.56b. The intersection of the half-sphere by the extended faces of the cube leaves four semi-circles. Between them are the pendentives.

2.56c. A dome is usually supported by a drum resting on pendentives.

2.56d. A drum and a lantern enhance the uplifting impression of a dome.

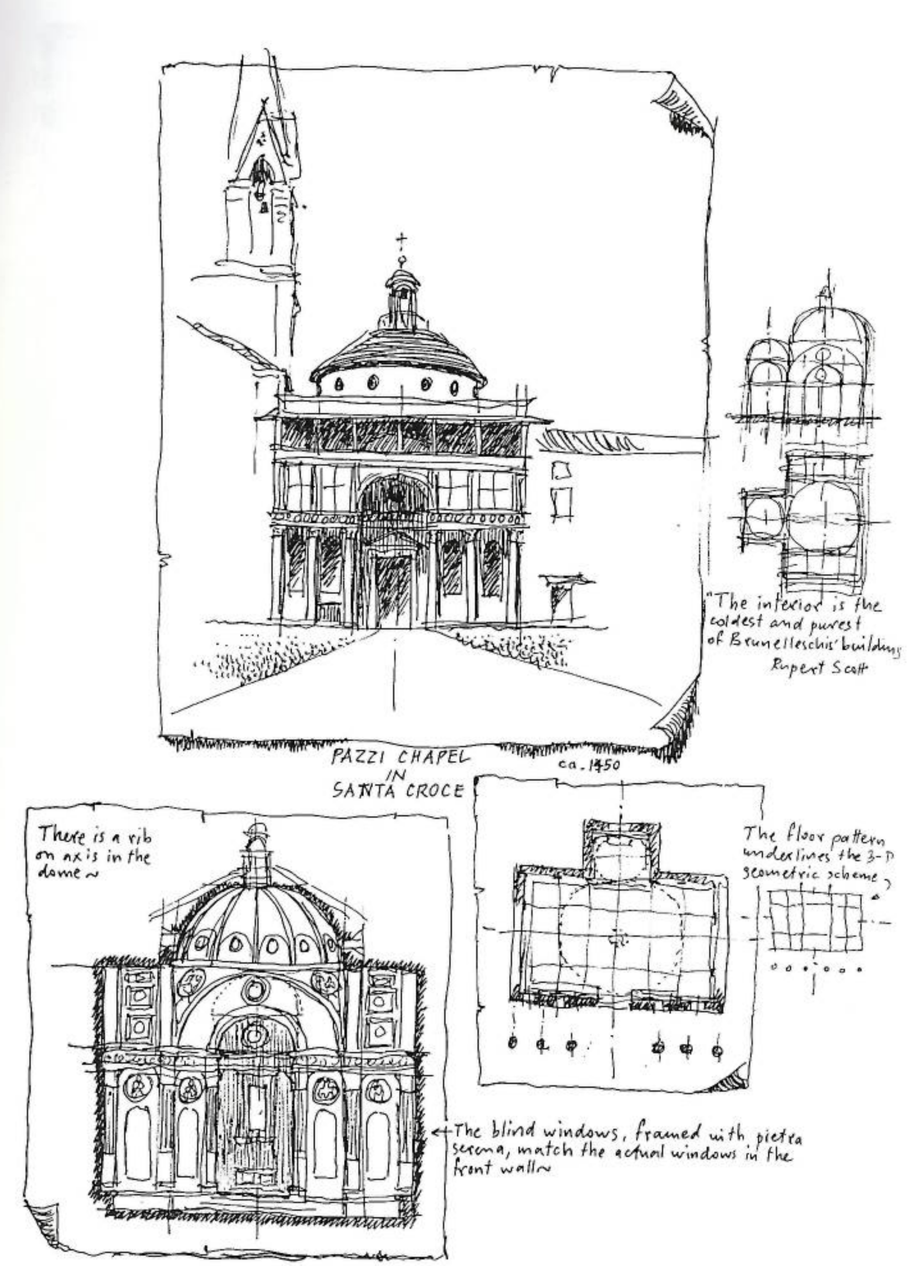
2.56e. The saucer dome is made visible by the simple insertion of a circular molding above the arches.



2.57. A comparison between a dome over pendentives and a pendentive or sail vault dome. The dotted line on the right represents the artificial boundary of a saucer dome.

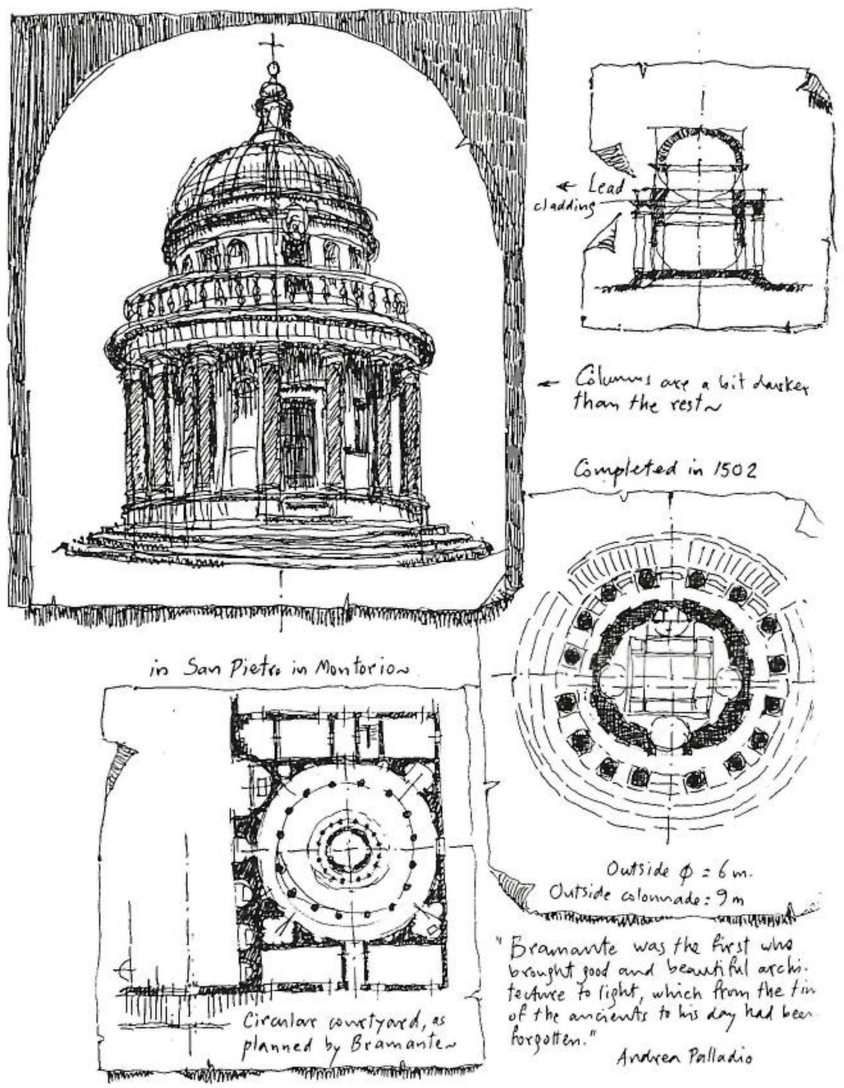
the cube (fig. 2.56a). If we extend the vertical faces of the cube and allow them to section off portions of the sphere, four semicircles appear. What remains of the spherical surface is a dome, called a *pendentive* dome or *sail vault*. The pendentives themselves are four spherical triangles (fig. 2.56b). A smaller dome is generally built on top of the pendentives, and in most cases a cylinder, referred to as a *drum*, is inserted between the dome and the pendentives. The drum is a good place for windows, and the heightening of the interior space greatly enhances the effect (fig. 2.56c). Frequently, another opening is created at the very top of the dome for additional light, and a *lantern* is placed over it to keep the weather out. This is a formal necessity. The intersection of the vertical axis with the outer surface of the dome is critical and must be visible. The exterior appearance of a dome is generally much improved by the addition of a lantern (fig. 2.56d). The *saucer dome* is a direct application of the pendentive dome. When a molding tangent to the top of the pendentives is placed on the spherical surface, the illusion of a distinct dome is created (figs. 2.56e, 2.57).

Not surprisingly, the symbolism of the cube, representing the earth, and the symbolism of the sphere, representing the universe, have made the combination of the two forms a natural for the design of sacred buildings (figs. 2.58, 2.59, 2.60).



2.58. Pazzi Chapel, Florence, c. 1450. Filippo Brunelleschi. The section shows a dome supported by pendentives. The same geometry is found in the apse in a diminutive version. Although the exterior view shows a drum, there is none. The circular windows are situated in the lower part of the dome itself.

2.59. S. Maria della Consolazione, Todi, near Perugia, begun in 1509. Attributed to Bramante or Baldassarre Peruzzi. A remarkable essay in pure geometry, it consists of a cube surmounted by a cylinder capped by a half-sphere. Semi-domes are applied to all four lateral faces of the cube.



2.60. *Tempietto at S. Pietro in Montorio, Rome, completed in 1502. Bramante.*

2.61. *Pendentive domes at the Mercato Vecchio, Florence. 1568. Giorgio Vasari.*

2.62. *Pendentive domes in the twin arcades of Place Louis XV, completed c. 1763. J. A. Gabriel.*

This does not mean, however, that domes cannot be used in secular building programs. At the Mercato Vecchio in Florence (fig. 2.61) and at Place Louis XV (now Place de la Concorde) in Paris (fig. 2.62), a series of small pendentive domes cover arcades.

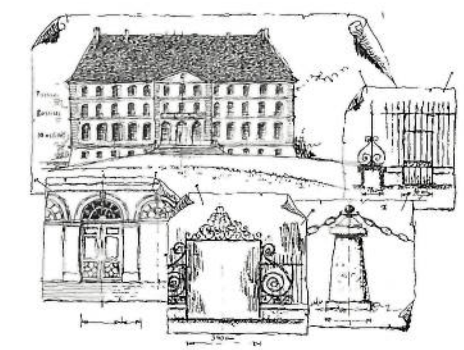
ROOFS

Roofs have always had an important role in architecture: they have enormous expressive power. To protect buildings as well as their occupants, roofs must extend beyond the outer walls. It is the lateral extension and the height of a roof that gives us such a comforting feeling at first sight (fig. 2.63). The slope of a roof is determined by the climate and by the roofing material, but, in their eagerness to emulate Italian models, classical architects have occasionally sacrificed roofs. The roofs of neo-Palladian buildings are often hidden, but many architects of the seventeenth and eighteenth centuries integrated high and steep roofs in their designs. Among those, Louis Le Vau and François Mansart stand out. In ordinary, anonymous buildings, prominent roofs are commonplace (fig. 2.64). One of the best ways to give unity to a building is to put a roof over it and to give all the slopes the same slant.

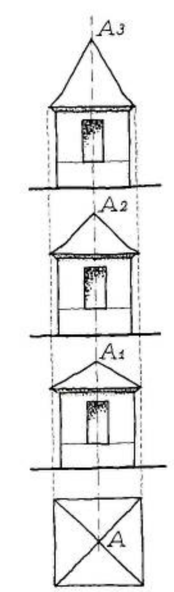
Let us look at a simple, square building. It is normally capped with a pyramidal roof. When the four faces of the pyramid have the same slant, the apex A is at the center of the roof plan (fig. 2.65). Intersections of the roof planes are drawn at a 45-degree angle in plan regardless of the height of the apex. It is on the elevation that the true slope is revealed; as a consequence, any number of different elevations (A1, A2, and A3) can share the same plan.

When the parts of a building differ in height, they might have discrete roofs that do not intersect. Drawing the roof plan presents no difficulty (fig. 2.66). But if the eaves of a roof are all at the same level, the height of the roof increases in proportion

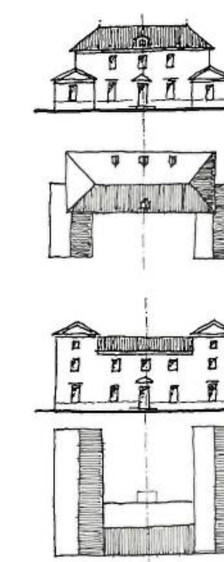
2.63. *Old roofs in Basel, Switzerland.*



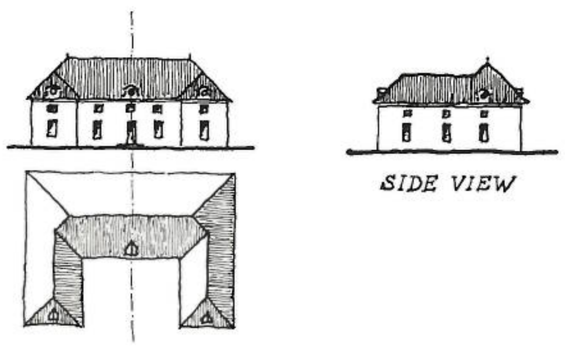
2.64. *The entry facade of the eighteenth-century Thénissey chateau, in Burgundy. Architect unknown. The monolithic form of the roof shelters the entire building.*



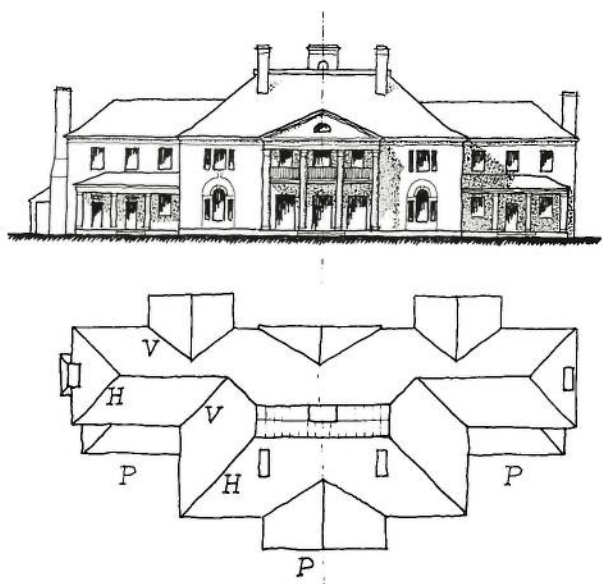
2.65. *Triangular faces of a regular pyramid lean at the same angle; therefore, the apex is at the center of the square plan. The roof plan is the same regardless of roof slopes.*



2.66. *In these two buildings, the wings and the center are of different heights. Each part has its own roof.*



2.67. *When the slopes are all the same, the height of the roof depends on the width of the building parts.*



2.68. *Farmlands, Cooperstown, New York, 2000. Fairfax & Sammons. On the roof plan, the intersections of roof planes are drawn at 45 degrees, indicating that the slopes are identical. Hips are marked "H" and valleys "V." The roof planes of the porch and pediments are shallower. They are marked with the letter "P."*

to the width of the building, and there will be intersections between the roof planes (fig. 2.67). These intersections are either convex (*hips*) or concave (*valleys*). With practice, one learns to "read" a roof plan, that is, to form a mental picture of the building in three-dimensional space (fig. 2.68).

Mansard roofs are well adapted to wet climates. High enough to accommodate one or two more stories, such roofs convey a pleasant domestic feeling (fig. 2.69). As is often the case, a simple graphic method generates a harmonious form in space, for the profile can be fitted in a semicircle bisected by 45-degree lines (fig. 2.70).

Dormers add variety and can contribute to the unity of a design when they are faced with the same material as the wall below (fig. 2.71).

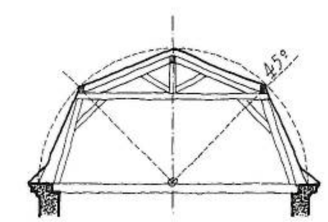
The shape and the relative height of roofs can express the hierarchy of the different parts of a building. At Vaux-le-Vicomte (fig. 2.72), cubic forms reinforce the four corners while the dominant mass in the middle of the garden facade is capped with a dome.

ORNAMENT

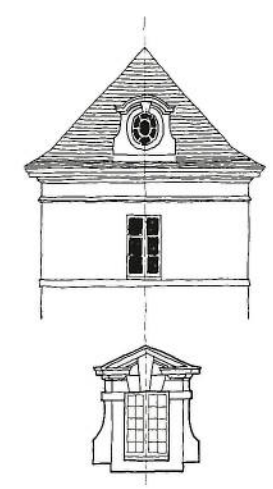
All cultures around the world have used ornaments in a meaningful way for millennia, but after the industrial revolution, ornamentation became an emotionally charged issue. Modern architects have looked at ornament with suspicion, considering it immature, immoral, or in bad taste. In 1892, Louis Sullivan expressed hostility to ornamentation, or to what he thought was bad ornament, when he advised architects to refrain from using ornament altogether for the next fifty years.

Ornament is an integral part of classical architecture. Columns are both structural and ornamental, and windows are functional and ornamental at the same time (fig. 2.73). Similar relationships exist between all things classical, large and small, from decorative drawer pulls and door bells to large urban compositions (fig.

2.69. *The buildings of the Notre Dame market in Versailles. The buildings are wide enough to allow for a second story under the upper part of the mansard roofs.*



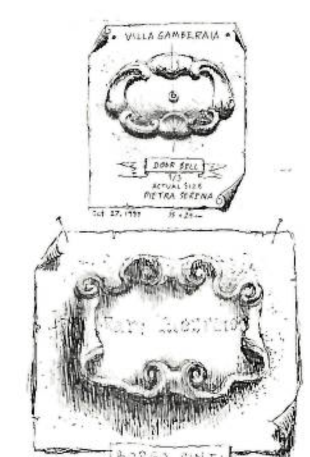
2.70. *A simple method to determine the cross section of a mansard roof.*



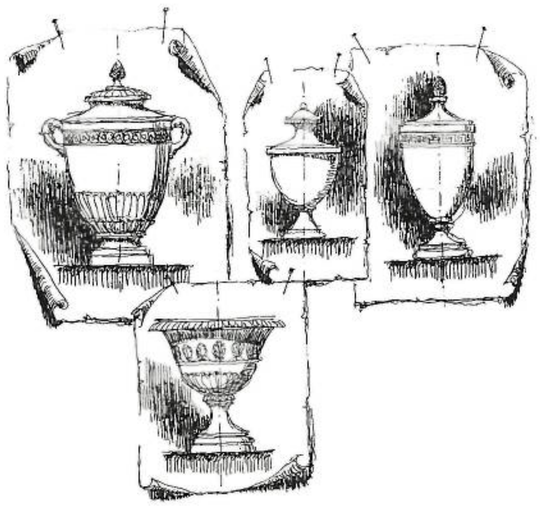
2.71. *Two classical designs for dormers; the one below is shown out of context.*

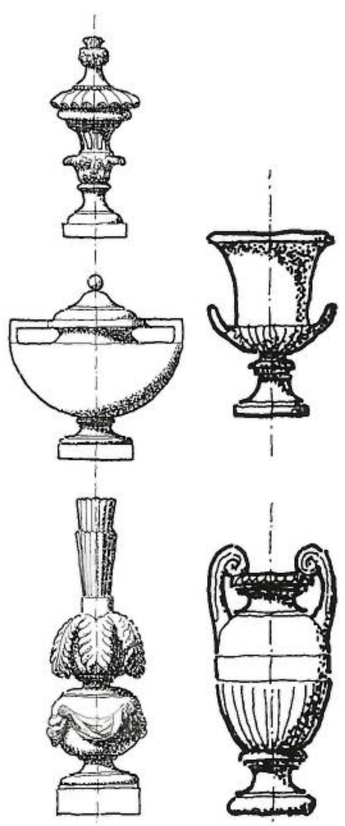
2.72. *Vaux-le-Vicomte, near Paris, construction interrupted in 1661. Louis Le Vau. On the garden facade, cubic forms underline the four corners while the oval room in the center is covered with a dome.*

2.73. *Ionic capitals at Hendricks Interfaith Chapel, Syracuse University, Syracuse, New York, 1929. John Russell Pope.*

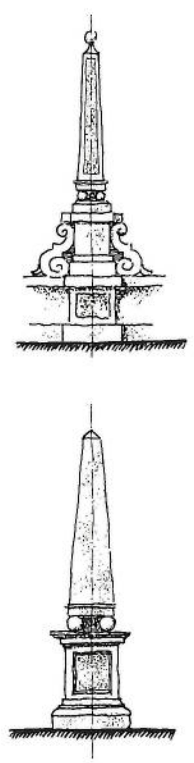


2.74. *Doorbell button at Villa Gamberaia and a name plate in a street in Florence, both made of "pietra serena" and forming an integral part of the walls.*





2.75. Urns, vases, and finials.



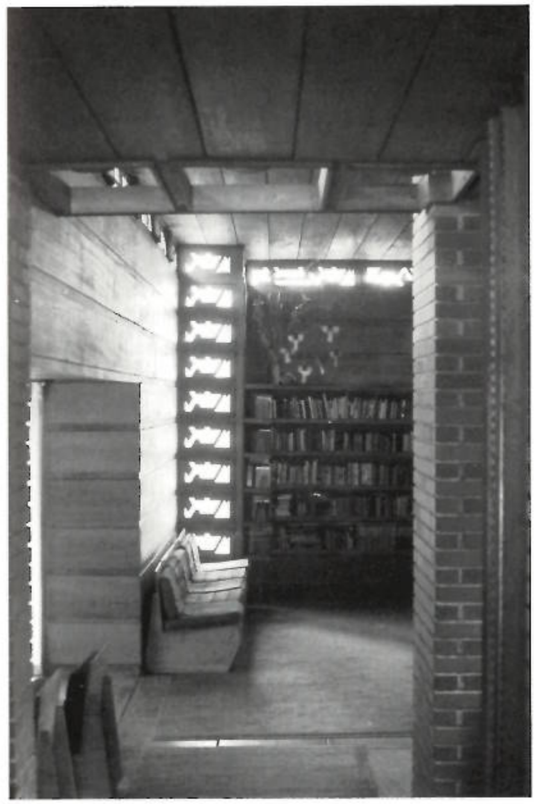
2.76. Two obelisk designs.

2.74). Classical ornament takes many forms: urns, vases, fountains, benches, topiary, pools, obelisks, finials, arbors, sculpture—allegorical, mythological, symbolic, or purely decorative—and even pavilions (fig. 2.75). Obelisks (fig. 2.76) are especially powerful as symbols of time: they stand for the seasonal cycles, the ebb and flow of fortune, life, death, and rebirth.

Applied ornament includes shields, friezes, wreaths, masks, trophies, frames, garlands, reliefs, swags, scrolls, medallions, mosaics, lettering, and more. The context is perhaps the most important issue; an ornament out of place is not only a mistake in itself, it can ruin an entire design.

It is their uselessness that makes ornaments important. When Oscar Wilde said that only luxury was indispensable to him, he was using a paradox to make a point. More recently, Walter Gropius insisted that spiritual needs were as important as physical needs. Beautiful ornaments have, like music, the power to make us feel happier.

Nearly alone among the architects of his generation, Frank Lloyd Wright incorporated ornaments in his buildings, even in the simplest and least expensive and in the face of declining craftsmanship and rising costs. Each of his Usonian houses was given an original design for cut-out plywood panels that were multiplied as many times as necessary to animate clerestory or vertical windows. Glass sheets were sandwiched between two sheets of plywood (figs. 2.77, 2.78). This proves that a resourceful mind can overcome stringent economic constraints; that the decorative effect of a simple motif relies on repetition, and that mechanization does not prevent effective ornamentation. These points were understood in the early nineteenth century. Using geometric forms and two-fold symmetry, designers had managed to create handsome patterns specifically conceived for mass-production in cast iron. The resulting pieces were destined to replace expensive wrought-iron elements, but it is worth observing that they did not imitate them (fig. 2.79).



2.77. Medical building, San Luis Obispo, California, 1955. Frank Lloyd Wright.

2.78. Pope-Leighey house, Falls Church, Virginia, 1940; moved to Woodlawn Plantation, 1964. Frank Lloyd Wright.

2.79. Cast-iron panels in an early nineteenth-century door, Troyes, France.

The representation of the human figure is the ultimate ornament in classical architecture, the architecture of humanism. The beautiful body becomes a metaphor for human virtues. It is to honor their status that statues are given prestigious settings; they are enshrined in niches, elevated on pedestals, or framed by pediments.

Classical buildings use symmetry, regularity, and every possible symbol to convey an impression of solidity and immutability. It is against that background that stone and bronze figures (fig. 2.80) are asked to suggest just the opposite: the animation of life. Those that seem to be in motion or about to start moving are compelling, and there are few that take a rigid pose.

2.80. Statue on a pedestal in the garden of the Palazzo Medici-Riccardi, Florence.