I

NUMBER AND ARCHITECTURAL PROPORTION IN THE SEVENTEENTH AND EIGHTEENTH CENTURIES

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CLAUDE PERRAULT AND THE INSTRUMENTALIZATION OF PROPORTION

Not until recently has the significance of Claude Perrault's work in relation to the origins of modern architecture been properly appreciated.[1] My concern will be to examine his contribution to the process of mathematization of architectural theory, the meaning of his progressive position in the famous Dispute of the Ancients and the Moderns (*Querelle des Anciens et Modernes*), and the almost total rejection or misinterpretation of his work by eighteenth-century architects.

It is important to emphasize that during the seventeenth and eighteenth centuries, architectural theory was not founded on independent premises but existed within an epistemological framework in which not even the distinction between the sciences and the humanities was clear-cut. Architectural theory had enjoyed an autonomous universe of discourse since the Renaissance, but its ultimate frame of reference remained outside itself. In this sense, Claude Perrault's universal interests were in the best tradition. He was not only the author of an important architectural treatise, editor and commentator of a new translation of Vitruvius's *Ten Books*, and the reputed architect of the eastern facade of the Louvre, but possessed a brilliant and far-ranging intellect. Originally trained as a physician, he devoted a great part of his life to scientific research, and his understanding of seventeenth-century science and philosophy was thorough. He wrote on many scientific topics and participated in the activities of the Royal Academy of Science. His achievements should not be considered independently; a coherent intention lay behind his scientific and architectural interests.

Perrault's writings date from the last third of the seventeenth century. This was a period in the history of Western culture in which most implications of the Galilean scientific revolution were generally accepted. Thought was no longer perceived as a closed process, leading by necessity to universal truths prescribed by divine revelation. Modern science, as opposed to its ancient and medieval counterpart, had ceased to be a hermetic discipline whose transcendental conclusions existed beforehand.[2] In his *Novum Organum*, Francis Bacon denied the authority of ancient writers. Qualifying traditional philosophical systems as "comedies," evocative of imaginary worlds, Bacon proposed a new type of knowledge that derived from the observation of natural phenomena and was independent of transcendental issues. This implied the possibility of a philosophy in constant development, moving toward the utopian perfection of absolute rationality.[3] The history of science was regarded by Bacon as progress, an accumulation of valuable experience gleaned from the past, to be used by a community of intellectuals looking toward the future. Knowledge could thus become a collective task of humanity, capable of being shared and transmitted, constantly increasing and growing. The result would be a single scientific tradition, a product of necessity, the only true knowledge, in contrast to the long-standing conflict among philosophical systems.[4]

The "new science" of Galileo was more than just another cosmological hypothesis; it implied a radical subversion of the traditional astrobiological world view. The new science pretended to substitute for the reality of the live world, infinitely diverse, always in motion and defined essentially by qualities, a perfectly intelligible world, determined exclusively by its geometrical and quantitative properties. An idealized, geometrical nature replaced the mutable and mysterious *physis* that man had always perceived. In Galilean thought, visible reality loses importance in order to come to terms with a world of abstractions, relations, and equations. In this world, truth becomes transparent, but only to the degree to which it avoids the irregularities of lived experience. Galileo meant to describe in mathematical language the relations among the diverse elements of natural phenomena.

Following upon the work of Galileo, scientific phenomena came to be regarded not simply as what can be perceived, but primarily as what can be conceived with mathematical clarity. Things became numbers, not understood as their Platonic or Pythagorean transcendental essences, but as objective and intelligible forms. The book of nature was written in mathematical terms, and man began to think that he could manipulate and dominate effectively this objective, external reality. Galilean science thus constitutes the first step in the process of geometrization of lived space; it was the beginning of the dissolution of the traditional cosmos.

But the seventeenth century was not positivistic. It was a time of divided epistemology. The Platonic systems of philosophers were deeply rooted in an Aristotelian world. Only a few exceptional scientists such as Galileo or Gassendi were able to realize the limitations of hypotheses. In contrast to the old occult disciplines, the new science would learn what knowledge was within its province and what knowledge was unattainable. But this awareness was never universal during the seventeenth century. Most scientists and philosophers were simultaneously traditional and progressive.[5] True, they all had greater confidence in the

Claude Perrault, engraved by G. Edelink (1690). The inscription praises his modesty, stating that no secret in nature or the arts has remained beneath his reach.

The hierarchical and animistic Aristotelian cosmos. An image of the world provided by Cesare di Lorenzo Cesariano in his edition of Vitruvius's *Ten Books* (1521).

evidence presented by mathematical reason than in the authority of ancient writers, which bespoke a belief in scientific progress,[6] but most philosophers still believed that mathematical thought constituted a privileged channel of communication between human minds and the divine mind.

Cartesian philosophy and the new science of Galileo postulated the initial split between the perceptual and conceptual spheres of knowledge. Afterward, Western science and philosophy concentrated its attention on truth rather than on reality. The value of a system depended on its clarity and the evidence for its ideas and relations. During the seventeenth century, however, the necessary correspondence between the ideas of the subject and the reality of the object was guaranteed by a benevolent God who had created the universe on the basis of geometrical laws. Scientists and philosophers built vast conceptual systems based upon a mechanistic logic of causes and effects that explained the phenomena of nature. But these systems were always closed and concerned ultimately with final causes.

The notion of progressive knowledge (open to the future), empirical and not hypothetical, became much more explicit in the intellectual climate of the last third of the century. The creation of the academies and the Dispute of the Ancients and the Moderns are two very important events that embody this transformation. In both, Claude Perrault played a major role.

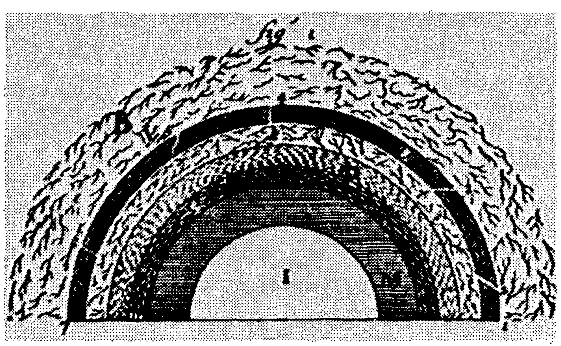
Perrault was a founding member of the French Royal Academy of Science (1666) and the author of its original research programs in anatomy and botany.[7] The academy, as well as its English counterpart, the Royal Society of London, regarded itself as a contributing factor in Bacon's utopia: each member working in his specific area of knowledge for the benefit of mankind. The importance of these new institutions cannot be overemphasized. In sharp contrast to the Christian universities that rejected Cartesianism during the seventeenth and eighteenth centuries, the academies, patronized by the civil authoritites, provided an ideal framework for the development of the new science.

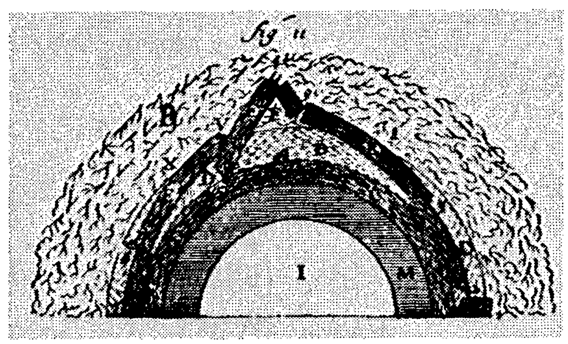
The Dispute of the Ancients and the Moderns divided French intellectuals on the issue of ancient authority. Claude and his famous brother, the writer Charles Perrault, defended the moderns. The meaning of their position is obviously complex. Some authors have emphasized the literary origin of the *querelle* and the dimension of personality conflict it contained.[8] The moderns were mostly French, and the Perrault brothers were very close to the court. Their passionate defense of modern science, however, had further implications.

Charles Perrault described the conflict in the four volumes of his *Parallèle des Anciens et Modernes.*[9] After acknowledging in the preface that there were excellent ancient authors, he quickly proclaims the superiority of the moderns. Charles was well aware that the old order of natural philosophy had discouraged experimentation in the belief that it was sufficient to take the truth from literary sources, learning from Aristotle and his interpreters. Perrault considered this attitude to be inadequate, favoring instead the moderns who searched for the immediate knowledge of nature's works.

The position of the Perrault brothers in relation to Descartes is illuminating. Charles had credited this *homme extraordinaire* with the refutation of Aristotelian philosophy, while Claude used Cartesian models for his work in physics. But Charles also criticized those who believed in the Cartesian system literally, assuming that it disclosed the final causes of nature.[10] Charles was referring to the system of the world postulated by Descartes in his *Principles of Philosophy.*[11] As an introduction to this text, Descartes wrote a dissertation on the principles of human knowledge emphasizing the existence of certain notions, "so clear in themselves . . . that they cannot be learned . . . being necessarily innate." We might question the truth of the sensible world, but can be assured that God would never intentionally fool humanity. Since knowledge is God given, all that we perceive clearly and distinctly, "with mathematical evidence," must be true. The text, rejected as pure imagination by the eighteenth-century *philosophes,* is a collection of amazing and often beautiful mechanical dreams that attempt to explain all possible phenomena: from the constitution of the universe to the essence of fire, magnetism, and human perception. Descartes believed that his mechanistic system, one that explained in a clear and distinct manner the phenomena of nature through causal relations, must be true and had priority over any perceptual evidence.

The difference between the intellectual positions of Descartes and the Perrault brothers had a theological dimension. Although Descartes proposed that "we should prefer divine authority over our reasoning,"[12] his work was condemned by the Church. This condemnation, like Galileo's famous trial, referred not only to a specific philosophy or astronomical system but to the total subversion of the traditional order. While Descartes still tried to rec-





Frontispiece of Claude Perrault's *Histoire des Animaux* (1671). This engraving by Sebastien Le Clerc shows the king visiting the Academy of Science. The observatory, for which Perrault supplied the design, is being built in the background.

Plate from Descartes's *Principes de la Philosophie*, illustrating the different density of matter and its effects in the author's vortex theory.

oncile philosophy and theology in an almost medieval fashion, the Perrault brothers were clearly more modern in their attempt to separate faith and reason, thereby avoiding insoluble conflicts.

This difference in their methods reflects their positions in relation to the ultimate validity of a priori conceptual systems. While Descartes had criticized the open and unsystematic character of Galileo's work,[13] the Perrault brothers clearly recognized the limitations of closed hypothetical systems. In the epistemology of the modern world, the sphere of transcendental causes becomes increasingly more alien. The domain of God is outside reason. Thought concentrates its interest on how things come about and stops asking why. An investigation of laws, of necessary and mathematically determined relations, was more appealing than seeking final causes. Claude Perrault defined phenomenon as "that which appears in Nature and whose cause is not as evident as the thing."[14]

Such a distinction is symptomatic of a true protopositivism and was evident in French intellectual circles between the last decades of the seventeenth century and the 1730s, when the natural philosophy of Newton became generally accepted in Europe. Claude and Charles Perrault were able to distinguish truth from illusion, dissociating scientific knowledge from mythical thought. After discussing astronomy, telescopes, and microscopes in the *Parallèle*, Charles dismissed astrology and alchemy as purely fantastic and whimsical disciplines, lacking any real principles. "Man," he wrote, "has no proportion and no relation with the heavenly bodies . . . infinitely distant from us."[15] Perrault made a distinction here between the new science and traditional hermetic knowledge, disciplines that were usually confused in the earlier part of the century. It may be remembered that between 1570 and 1630, approximately 50,000 women were burnt at the stake, accused of witchcraft. Aside from sociological conditions, this atrocity was a consequence of the confusion between magic and science, linked to the Renaissance discovery of man's power to transform his internal and external reality. It was only in 1672 that the minister Colbert passed a decree stipulating the illegality of such accusations.[16]

Charles already finds it incredible that some modern authors do not accept the irrefutable evidence of blood circulation or the astronomical systems of Copernicus and Galileo. After discussing the values of modern and ancient arts and sciences, including war, architecture, music, and philosophy, he concludes that with the exception of poetry and eloquence, the moderns were always superior.[17] The Dispute was therefore much more than a literary quarrel or an apologia for French seventeenth-century authors. It was an affirmation of faith in progress and militant reason, a faith that rejected the type of knowledge that Descartes still upheld, founded on belief in the transcendental power of thought and immediate access to divine truth.

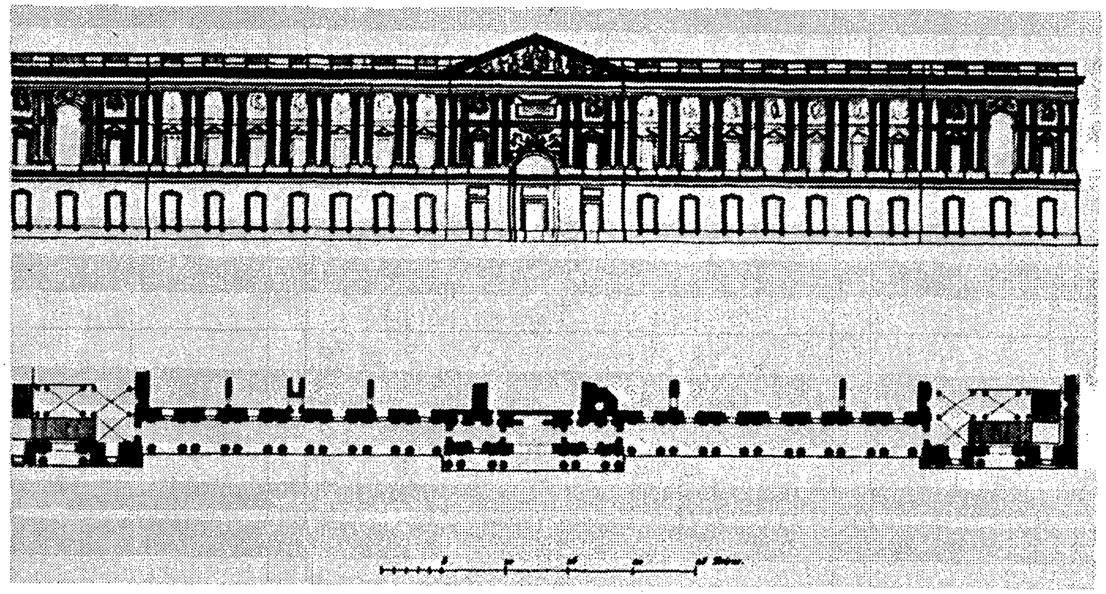
In his *Essais de Physique* (1680), Claude Perrault distinguished between theoretical and experimental physics, emphasizing the secondary value of conceptual systems or hypotheses postulated a priori.[18] Referring to the explicative systems that he himself puts forward, he admits that their value does not derive from their superiority to other similar ones; their worth is, in his opinion, more a result of their novelty. In this manner, Perrault admits total freedom to the construction of hypothetical systems and even justifies the "extravagant imaginative discourses of some celebrated philosophers." He believed that ultimately "truth is but the totality of *phenomena* that can lead us to the knowledge of that which Nature wanted to hide. . . . It is an enigma to which we can give multiple explanations, without ever expecting to find one that is exclusively true."[19]

Perrault considered exactness in the inductive process to be much more important than deductive constructions. His notion of system was no longer linked with that of a cosmological scheme; he repudiated the claim that it had transcendental power as a *clavis universalis*, a key to universal reality.[20] System now designated merely a principle of constitution, a structural law.[21] Emphasizing his distinction between perceptually evident truths and illusory causes, he pointed out that although many readers might disagree with his philosophical explorations, his *Essais* still contained a great number of positive and constant discoveries that would stand on their own.[22] Perrault believed that it was better to accept many hypotheses to explain the different aspects of nature than to try to postulate a single, exclusive explanation.[23] This relativistic dimension of systems is always evident in his work. True causes, he believes, are always occult, and probability can be the only result of reasoning.

Nevertheless, Perrault emphasized in different contexts the impossibility of "philosophizing without putting forward propositions of a general character."[24] He seemed to be aware of the dilemma of modern science: "Philosophical physics reveals an ambition of synthesis and deduction at a moment in which acquired knowledge is still insufficient," while "historical physics" collects precise information through an inductive method, being excessively humble and prudent.[25] It is significant that in spite of his recognition of the limitations of systems as artificial and non-transcendental, Perrault always presented his discoveries precisely in this fashion—an attitude that could be qualified as simultaneously positivistic and traditional.

It is well known that Perrault designed very few buildings; even his authorship of the Louvre Colonnade has been questioned. Undeniable, however, is his profound influence upon successive generations of architects.[26] Beyond his formal contributions, which were fundamental models for French Neoclassical architecture, is a basic architectural intentionality that can only be understood in relation to his epistemological presuppositions. Perrault's theoretical writings on architecture, the preface and notes to his edition of Vitruvius, and his treatise, *Ordonnance des Cinque Espèces de Colonnes* constitute a fundamental point of departure for modern architecture.[27] Perrault questioned the most sacred premises of traditional theory, especially the idea that it was something given beforehand. In a note on his edition to Vitruvius, where he justifies his use of double columns in the facade of the Louvre, he refuted François Blondel's criticism: "His main objection . . . is founded on a prejudice and on the false supposition that it is not possible to abandon the habits of ancient architects."[28] Perrault admitted that opening the way for beautiful inventions could be dangerous, encouraging excessive freedom and giving rise to extravagant or capricious buildings. But, in his opinion, ridiculous inventions would destroy themselves. If the law that stipulates the necessary imitation of antiquity were true, he wrote, "we would not need to search for new means to acquire the knowledge which we are lacking and that every day enriches agriculture, navigation, medicine, and all the other arts."[29]

In the epistemological revolution of the seventeenth century, it was knowledge as a whole that became an unfulfilled task. The arguments that Perrault considered convincing in scientific thought were to his eyes equally valid when applied to architecture. In his preface to the *Ordonnance,* he concludes that "one of the first principles of architecture, equal to the other arts, is that it has not yet arrived to its final perfection."[30] In spite of his unquestionable pride and his belief in the perfection of his own theory, Perrault expressed a desire that his conclusions on the rules of the classical orders could be made some day even more precise



Perrault's design for the eastern facade of the Louvre with its controversial paired columns, from Quatremère de Quincy's *Histoire de la Vie et des Ouvrages des Plus Célèbres Architectes* (1830).

and easier to remember. The relevance of this position, obviously in accord with his defense of the moderns in the Dispute, cannot be overemphasized. Notions about the perfectibility of the arts had been expressed before, particularly during the second half of the sixteenth century, but these were mostly echoes of ancient doctrines. Perrault turned his face toward the future, conceiving his theory of architecture as a stage in a continuous line of development in a process of ever increasing rationalization; possessing the accumulated experience of the past, modern architecture was necessarily superior.

This truly modern ideal of a progressive architecture was one of the most profound reasons behind the foundation of the Royal Academy of Architecture in 1671. The direct role that Perrault played in it has never been clear,[31] but the academy was the first institution devoted to the rational discussion of the fundamental problems of architecture and the structured education of future architects. Traditional apprenticeship or the training in the mechanical arts provided by the medieval masonic guilds was obviously inadequate.[32] The architecture of the modern world put an unprecedented emphasis on rational theory; the superiority of modern architecture became a fundamental premise, and this belief, often implicitly, is still prevalent today. The way in which the menacing and contradictory implications of this belief were reconciled with traditional values during the eigthteenth century will be discussed in the following chapters.

After declaring his faith in a progressive architecture, Perrault established in the *Ordonnance* a system of proportions for the classical orders that he considered to be perfect and conclusive. His dimensional system is truly novel. Rejecting all other systems generally accepted in his own time and criticizing their complicated subdivision of modules, he postulated a method that consisted in dividing the major parts of the building in relation to whole numbers. A considerable section of the *Ordonnance* is taken up by Perrault's calculations of the most appropriate dimensions for each of the parts of the classical orders. His method consists in finding an average between two extreme dimensions, taken from buildings, designs, or treatises by the best ancient and modern architects.[33] The arithmetic mean, a most appropriate conceptual expression of the *juste milieu,* was for Perrault a rational guarantee of perfection. In view of the fact that he considered architecture not determined "by proportions that might be true in themselves . . . we must examine the possibility of establishing *probable* dimensions, set firmly on the basis of positive reasons, but without distancing ourselves excessively from the proportions that we have received and are normally used."[34]

An examination of Perrault's text immediately betrays a great number of errors and discrepancies in the determination of the average proportions. His mathematical calculations are ultimately immaterial since his conclusions are barely affected by them. The system of dimensions postulated by Perrault is, in effect, an a priori invention, conditioned only by the most general appearance of the traditional classical orders. The theory of the *juste milieu* and the invocation of famous architects are only a means to render his proposition legitimate. But Perrault was fully conscious of the subversive implication of his system, which amounted to an arbitrary and conceptual construction that was, in essence, disrespectful of the rules of the great masters.

What was then the real motive behind Perrault's complex and time-consuming task? In the *Ordonnance*, he characterized the opinions of his contemporaries about the five classical orders as "confused." He complained that there were no certain rules of proportion, remarking on the great discrepancies that existed among the well-known systems of Vitruvius and the Renaissance authors. Although they all depended on the same transcendental justification, Perrault was quick to point out that the dimensional relations among the parts of the classical orders always differed and never corresponded to the measurements of real buildings.

Although several authors of the seventeenth century, particularly Roland Freart, had already noticed this problem, it is significant that such discrepancies were never considered a fundamental problem before Perrault. In the *Parallel of the Ancient Architecture with the Modern* (1650), Freart wanted to demonstrate how the classical orders had been used in diverse manners by different authors.[35] But his criticism was directed precisely against those authors who "pretended to modify the classical orders through fantastic interpretations." Perrault, on the contrary, criticized "all those treatises that compared proportional systems from the past, without proposing a new conclusive one."[36] He believed that the treatises that recommended only one system were better. The problem had always been that no single architect "has had sufficient authority to establish laws that would be invariably followed."[37]

The observed divergencies became unacceptable to the critical rationalism of Perrault. In the preface of the *Ordonnance*, he expressed a wish to create a system of architectural proportions so simple and universal that it would solve the problem once and for all. It was to be a system that any architect, regardless of his talent, could easily learn, memorize, and apply, controlling through reason the irregularities of practice.[38] Unquestionably, the proportional rules established by Perrault fulfill his basic intentions. His *petit module*, a third of the diameter of a column instead of the traditional semidiameter, is the regulating dimension of the most important elements of each order. It allows for a sequential relation of pedestals, shafts, capitals, and entablatures. All the dimensions are presented as whole natural numbers, constituting a system of prescriptive instructions, easy to memorize and apply.

In order to achieve his objectives, however, Perrault had to *reject* the traditional symbolic implications of architectural proportion. In the same preface, he criticized the "spirit of submission and blind respect for antiquity" that was still prevalent in the arts and sciences. He then contended that, apart from the truths of religion, which should not be discussed, the remainder of human knowledge could be subjected to "methodical doubt."[39] Architectural proportion lost in Perrault's system its quality of absolute truth. Numbers no longer had their traditional magic power, their connotations as an essential form of divine revelation. Perrault was thus able to reduce the problem to the immanent discourse of reason, and at the same time question proportion's immemorial role as the ultimate justification of *praxis*.

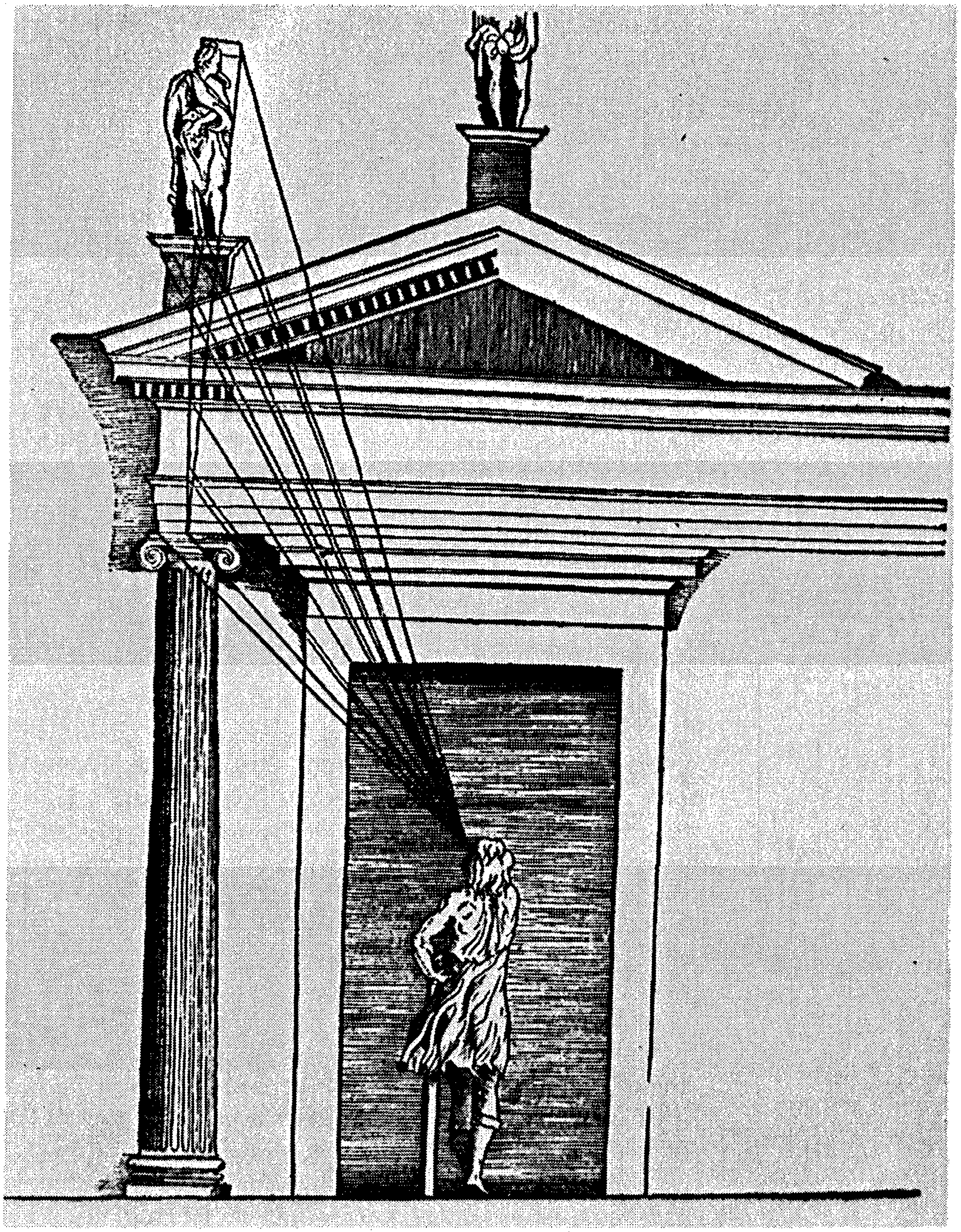
Perrault also rejected the traditionally recognized relation between architectural proportion and musical harmony. In the *Ordonnance*, he asserted that "positive" beauty did not depend directly on proportion, but was generated by visible aspects. He cited three fundamental categories: (1) the richness of building materials, (2) the exactness and propriety of execution, and (3) a general symmetry or disposition. Numerical proportions, on the other hand, could not be accepted as a guarantee of beauty. According to Perrault, these changed constantly, "like fashion," and were dependent only on custom.[40] For the first inventors of proportion, imagination was the only rule, and when "this *fantasie* changed, new proportions were introduced that were also pleasing."[41]

In the *Parallèle*, Charles also pointed out that proportions had been modified through history. He assertively rejected the existence of any kind of relation between human proportions and the dimensions of columns, attributing this modern belief to a false interpretation of Vitruvius's *Ten Books*.[42] Vitruvius had mentioned the perfection of human proportions, dictated by Nature, as a model for architecture. In Charles's opinion, however, this never implied that buildings were to derive their proportions from the human body. In a short essay on ancient music, Claude meanwhile denied the mythical perfection of this art, traditionally a symbol of preestablished harmony in an Aristotelian cosmos.[43] In Claude Perrault's theory, architectural proportion lost for the first time, in an explicit way, its character as a transcendental link between microcosm and macrocosm.

Vitruvius had recommended the use of optical adjustments to correct the distortion of dimensions that occurred when buildings were viewed from certain positions. This argument had been taken up by most architects before Perrault to justify the discrepancies between the proportions stipulated in theory and the dimensions of real buildings. The resolution of such differences between the ideal and the real worlds had never been a problem for architects. They were seen as proof of the architect's ability to face the specific character of each building task. But Claude systematically refuted this interpretation. After showing in the *Ordonnance* how, in most cases, these discrepancies between theory and practice were not intentional, he questioned the validity of optical corrections. In light of his epistemological position, Perrault was confident in man's ability to perceive directly the undistorted mathematical and geometrical relations in a world that is already "given" in perspective.

Traditional optical correction (*perspectiva naturalis*) referred to a world where visual aspects of perception were not assumed to have absolute supremacy.[44] The optical dimension had to be matched to the primordial (preconceptual) embodied perception of the world, with its predominantly motor and tactile dimensions. In Perrault's theory, the ideal had absolute priority over physical reality. Theory thus became a set of technical intructions whose fundamental objective was to be easily and directly applicable.

Claude Perrault was obsessed with the transformation of theory into an *ars fabricandi*. His proportional system clearly reveals this intention. Due to his peculiar position in a metaphysical vacuum, he could be more radically modern than many of his successors. Nevertheless, it is important to remember that his protopositivistic attitude was never free from contradictions and has to be carefully qualified. Living in the time of Louis XIV, he had faith in the structure and ornament derived from classical antiquity. He never



Typical illustration of the need for optical correction in design, from the first French edition of Vitruvius's *Ten Books* by Martin and Goujon (1547).

questioned the validity of the classical orders themselves and appeared to accept their essential role in architectural practice. He even tried to justify his new system of proportion by declaring that it only modified minimally a few details "not important for the overall beauty of buildings."[45] Perrault's architectural intentions thus appear inconsistent on many levels. In the most profound sense, however, these are already the contradictions of modern architecture, appearing most explicitly in Perrault's still traditional world.

Perrault frequently resorted to the myth of ancient authority as a justification of his own theory. He even affirmed that his system of proportion, being the most rational, was a type originally recommended by Vitruvius.[46] This antique proportion, based on whole numbers and easy to remember, had been abandoned by modern architects only because it did not coincide with the artifacts and ruins of antiquity. Significantly, Perrault blamed the carelessness of craftsmanship for this lack of correspondence, imagining again a one-to-one relation between a rational theory and architectural practice.

Perrault had defined architectural beauty in terms of its visible aspects. For him the visible, or the phenomenon, is clearly distinguished from the invisible, or the speculative cause, with the former always having priority over the latter. Perrault's theory of architecture is the first in which the distance between a visible form and an invisible content becomes problematical. Such a disparity could only exist after the inception of Cartesianism. Many of the contradictions apparent in Perrault's work derive precisely from his different attitudes toward the perceptual and conceptual dimensions. In terms of visibility, Perrault accepted the conventional forms of traditional architecture while rejecting the magical implications of numerical systems as the invisible cause of beauty.

Although Perrault could point to the relativity of architectural proportions, he never questioned the traditional symbolic connotations of the classical orders. But it is important to note that architectural meaning was never perceived in terms of a style's formal coherence. Perrault used the term "Gothic order" to describe a church in Bordeaux and admitted that French taste was somewhat Gothic, differing from that of the ancients: "We like airiness, lightness and the quality of free-standing structures."[47] His "sixth order" of coupled columns was meant to reflect this taste, an obvious precedent of Neoclassical intentions. A good number of Perrault's contemporaries, both his immediate predecessors and his successors in France and England, were prepared to admit and appreciate the value of alternative systems of ornamentation, for example, Gothic and Chinese. The most important condition was always the presence of an invisible *mathesis*, which assured the role of architecture as a true art of imitation. Thus the relevance of Perrault's position on this issue. The question about the origins of modern architecture cannot be simply a matter of evaluating the extent to which the classical orders were used or rejected.

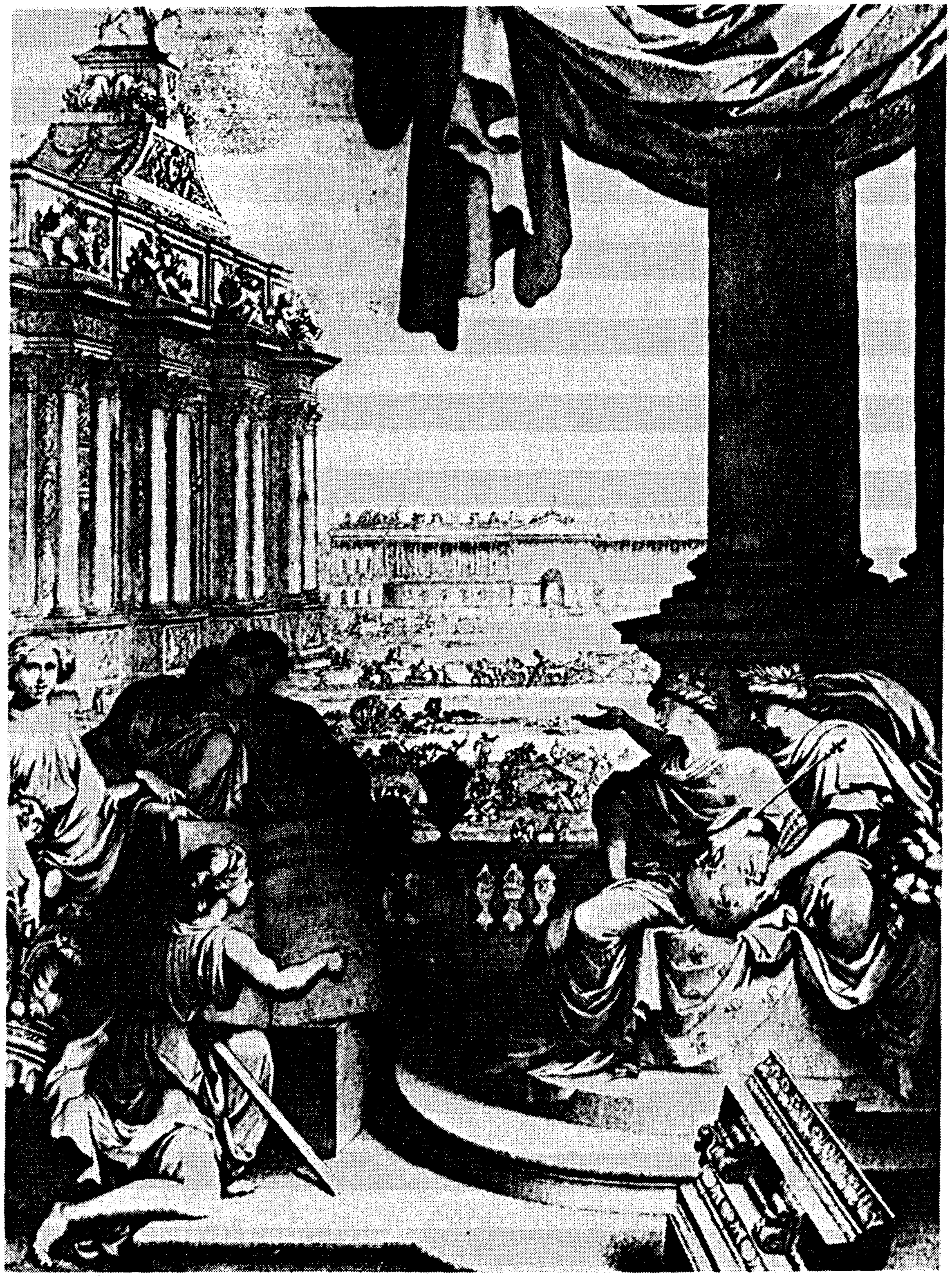
Charles Perrault was even more extreme in his *Parallèle*, in which he recognized the historical relativism of the forms and ornamentation of classical architecture. He believed that architectural ornament had the same character as rhetorical figure in language,[48] which is why all architecture must use it. The merit of an architect, however, was not in his ability to use columns, pilasters, and cornices, but in "the placement of these elements with good judgment in order to compose beautiful buildings."[49] The actual form of such ornament "could be totally different . . . without being less pleasant, if our eyes were equally accustomed to it."[50] Charles seemed ready to declare that beauty derived only from a formal or syntactic relation among the elements of a given ornamental system. Although he never did so, the way had been opened for others to question the traditional symbolic role of architecture as a whole.

Clearly, the Perrault brothers believed in the perfection of their own time.[51] In the preface to his edition of Vitruvius's *Ten Books*, Claude identified the Golden Age of Louis XIV with the mythical excellence of the Roman Empire. Architecture had to be conceived in terms of Roman prototypes.[52] Perrault particularly admired the richness and splendor of Imperial Rome. He believed that grand modern architecture had to recover those qualities of ancient building. This ideal, as well as his conviction that theory was absolutely essential, compelled him to translate and comment upon the treatise of Vitruvius. At the time, there was no adequate French edition of the Latin text, and Perrault believed that ignorance of the "original precepts" of architecture was a great obstacle to the revival of this art.[53]

Perrault was aware that the rules of Vitruvius constituted only one possibility among many. He justified his preference for the Roman by emphasizing the necessity of theoretical precepts: "Beauty has no other foundation than the imagination.... It is [therefore] necessary to establish rules that would form and correct the idea [that each one of us has of perfection]."[54] Perrault was convinced that rules are so necessary that if nature did not provide them for certain disciplines, then it was the responsibility of human institutions to supply them, "and for that there should be agreement on a certain authority as having the character of positive reasons."[55] But Perrault also adopted a critical attitude and pointed out that the authority of Vitruvius did not derive from a blind veneration of antiquity or from his association with a historical period identified with perfection. Nevertheless, in spite of his tone of scientific objectivity, Perrault certainly would not have embraced the gigantic task of translating and commenting upon the text of Vitruvius if he had not been convinced that it constituted "the original source of architectural rules"[56] and that "the precepts of this excellent author . . . are absolutely necessary to guide all those who want to attain perfection in the art of architecture."[57]

Perrault sincerely believed in the importance of Vitruvius's theory as the *fons et origo* of the great symbolic wealth that he admired in the architecture of the Roman Empire. Concerning the issue of proportion, however, Perrault declared in the *Ordonnance* that no author of the past had sufficient authority. The rules of proportion derive from custom, but are fundamental. It is here that the most revealing contradiction in Perrault's intentionality appears.

According to Perrault, a thorough knowledge of the rules of proportion is essential because they form the "taste that any true architect must have."[58] In Perrault's definition, "positive beauty" is visible; but precisely for this reason, it can be discerned by anyone with a minimum of common sense. It is simple enough to distinguish between rich and poor architecture, between a building executed with excellent craftsmanship and one badly constructed.[59] To succeed in his design, the architect must know the more subtle rules governing "arbitrary beauty." Although proportion might be arbitrary, established through custom and use, although it might not lead necessarily to positive beauty, it is still essential for the practicing architect. The accord or consensus derived from custom is still considered a positive frame of reference. The ambiguity, never fully understood by most eighteenth-century architects and theoreticians, is made explicit in a footnote to Perrault's edition of Vitruvius[60] in which he claims that customs are powerful enough to warrant the belief in some architectural proportions as being "naturally approved and loved." Identified with musical harmony, these proportions are assumed to possess true beauty.[61]



Perrault's designs for a triumphal arch and the Louvre, appearing in the background of the frontispiece of his edition of Vitruvius's *Ten Books.*

In Perrault's theory, proportions were identified through *association* with positive beauty. He is the first architect to question the traditional belief that meaning appears immediately through perception. Instead, he provides an associative, conceptual explanation of architectural value. His understanding of perception is already akin to that of modern psychology's: *partes extra partes*, which affirms the separation of optical, tactile, and auditive sensations, synthesized only in the mind.

Perrault invoked the authority of Vitruvius in an effort to escape the irreconcilable contradictions of his theory. The writings of the Roman architect were believed to embody the visible aspects of classical architecture. But proportion, the essential invisible cause, became as relative as any other conceptual explanatory system in Perrault's thought. This splitting of the architectural "phenomenon" would be taken for granted only in the practice of nineteenth- and twentieth-century architecture.

Perrault never denied the importance of *mathesis* in architecture. But conscious of the scientific revolution and its implications, he gave number a totally different role, using it as an operational device, as a positive instrument for simplifying the process of design or avoiding the irregularities of practice. His theory of proportion demanded absolute and direct control over the dimensions of the orders. The fundamental intention betrayed by such use of number is totally modern. His theory pretended to be a set of perfect, rational rules whose express objective was to be easily and immediately applicable. Perrault never went further. He did not attempt to mathematize human behavior or the structural stability of buildings, but he did lead the way toward a progressive architecture. Progress since then has become synonymous with the further reduction of architecture to mathematical reason.

It is well known that the technological dream of effective domination of matter through number and geometry became a reality only after the Industrial Revolution. But as soon as number had lost its symbolic connotations in philosophy toward the end of the seventeenth century, Perrault used it in his proportional system with the same intention. At the time, traditional systems of proportion were only "applied" through the personal experience of the architect and were postulated, essentially, as an elucidation of the reconciliatory nature of architecture and its meaning. In sharp contrast, Perrault's system pretended to be as perfect and universal as reason itself. Analogous to his physical systems, his set of a priori rules of proportion was devoid of all transcendental overtones. Its objective was to guide architectural design "in the least bad possible way," rejecting its traditional role as a source of absolute certainty.

François Blondel's Reaction

Most architects of the seventeenth and eighteenth centuries were interested more in the physical dimension of architecture than in ideal solutions. Consequently, they rejected or misunderstood Perrault's writings. His substitution of the practical realm for a conceptual, a priori system could not be easily admitted. Some architects simply ignored the more profound implications of his theory and considered the *Ordonnance* just another treatise on the orders.[62] Still others doubted the conviction behind his arguments. It was not difficult to find discrepancies between his theory and his few but famous buildings. It is important to remember that architectural *praxis* generally kept its traditional *modus operandi* during the seventeenth and eighteenth centuries.

Nevertheless, Perrault's writings created a significant theoretical discussion in which architects were to take sides for more than a hundred years. His theory was criticized initially by François Blondel, the engineer and architect responsible for the construction of several fortifications and who was the author of a course on mathematics, a treatise on bombs, a book on the mechanism of clocks, and a history of the Roman calendar. Like Perrault, he wrote an influential treatise on architecture and was a member of the Royal Academy of Science. He was not only a founding member of the Academy of Architecture but also the first official professor at that institution.

In spite of these similarities, however, Blondel's architectural intentions were still deeply rooted in the Baroque world of the seventeenth century. His understanding of science, philosophy, and mathematics is basically different from Perrault's, based as it is on a fundamental synthesis of the perceptual and conceptual dimensions of knowledge.

Blondel's epistemological context is indeed akin to Galileo's. But it must be remembered that even the Italian scientist was incapable of discerning clearly between "true causes" and "illusions" of an observed "effect." Although he could posit isolated discoveries without concern for final causes, rejecting the hierarchical and animistic cosmos of Aristotle, Galileo still believed that the human mind and the world were linked through geometrical structure, the result of preestablished harmony. It is now believed that a great number of Galileo's discoveries were the result of "experiments" that took place only in his imagination.[63] In the *Dialogue of the Two Sciences*, Galileo pointed out that the circle was perfect not only from an aesthetic or mathematical point of view but also where it concerned physical science.[64] His synthetic understanding of value as embodied in geometry was shared by seventeenth-century artists and architects.[65] Galileo identified geometry with nature. He believed the idea of a sphere or a circle was perfectly realized in each specific sphere or circle. The world was perceived as a constant materialization of geometry. During the seventeenth century, the mathematical sciences became a means of achieving the most abstract, and therefore the most valuable, imitation of nature.

Traditional Aristotelian philosophers distinguished the qualitative places of the central, permanently fixed world of man from the geometrical space of the stars and planets, which was conceived as a truly ideal entity. The hierarchy of places of the sublunar world could be identified with geometrical space only after man became a subject, a rational mind separated from the objective reality of the world. Only then could man pretend that real phenomena should be understood in the framework of an ideal space. This implied substituting an independent entity governed by the properties of geometrical space for the original and undifferentiated field of intentions where reality was constituted. In the modern universe, bodies become aggregates of material points, behaving mathematically in an infinite and homogeneous extension.

Seventeenth-century philosophers, scientists, and artists accepted that the book of nature was written in a mathematical alphabet. Because the figures of Euclidean geometry related to the perception of the real world, they were ultimately a product of intuition,[66] and thus geometry could become a *scientia universalis*, a symbolic science *par excellence*. Innate, God-given ideas were believed to derive from geometrical prototypes, as was the divine alphabet that had been impressed on the things of the visible world by the Creator. Seventeenth-century geometry provided a link with the higher realities that gave ultimate meaning to human existence. As a vehicle for the constitution of symbols, geometry became normative in the arts, music, and literature. Moreover, it became accepted as the only true mode of perception, a condition that one day would provide the context for the desecration and technological exploitation of the world.

Baroque architectural intentions, apart from the specificity of their cultural embodiment, such as the diverse buildings of Christopher Wren, Guarino Guarini, and François Blondel, were founded in this epistemological context. They shared to a greater or lesser degree this necessarily ambivalent interest in geometry and mathematics.

In the *Cours d'Architecture*, the first textbook for the students at the Royal Academy of Architecture, François Blondel criticized Perrault's theoretical assumptions from many revealing angles. Blondel reaffirmed the belief, commonly held since the Renaissance, of the great importance of theory.[67] Realizing, however, that the writings of Vitruvius only reflected the doctrines of the Greek architects that had preceded him and did not coincide "with the most beautiful remains from antiquity," Blondel also provided the rules given by other excellent architects, such as Vignola, Palladio, and Scamozzi.[68] His intention was to examine and compare these rules, showing where they concurred or differed, in order to establish those precepts that could be more universally accepted. This was, in his opinion, the only way to fashion the contemporary architect's taste. Clearly, Blondel's attitude contrasts with Perrault's desire to establish an exclusive, simple, and rational system of architectural proportion. Blondel did not believe that the difference of opinion among the great architects of the past constituted a real problem. He understood their writings to be essentially true insofar as they referred to the theoretical dimension of their unquestionably valuable work. The problem was always one of personal interpretation. The architect had to choose the most appropriate rules and apply them in each case through his personal experience.

Blondel discussed at length the problem of optical corrections, which he considered of great importance. He openly criticized Perrault on this issue. Using as evidence some famous buildings, he emphasized the need to adjust the dimensions of buildings so that their proportions might appear correctly in perspective.[69] Writing in italics, he asserted that the successful determination of the real dimensions of a building, once the increments and reductions of the original proportions had been considered, was precisely the aspect that revealed the architect's strength of intellect (*esprit*): "The result depends more on the vivacity and genius of the architect than on any rule that might be established."[70]

Claude Perrault had rejected optical adjustments, indicating that the human mind immediately corrected these distortions; his attitude was motivated by an obsession to reduce the distance between his rational theory and traditional practice. Blondel, on the other hand, still understood theory primarily as a transcendental justification of practice, recognizing a profound and noncontradictory continuity between both aspects. He emphasized the importance of personal expression and decision in architecture, an emphasis that Perrault's *ars fabricandi* would have gladly eliminated in favor of reason. The discrepancies between the diverse systems of proportion and the real dimensions of executed buildings, which became intolerable for Perrault, were perfectly justified in Blondel's theory.

In view of all this, it is significant to note Blondel's interest in mathematics. His passion for geometry was much greater than Perrault's. In a small book entitled *Résolution des Quatre Principaux Problèmes de l'Architecture,* Blondel pointed out that architecture was, in fact, a part of mathématics.[71] This was not an uncommon attitude among architects and philosophers of the seventeenth century, and Blondel, for one, maintained that all that was "good and magnificent" in architecture came from mathematics. The "principal" and most difficult problems were indeed propositions concerning statics and geometry.[72] He was convinced that much would be gained if architects studied mathematics and mathematicians studied architecture. The course of architecture that Blondel taught at the academy included, aside from the rules of the classical orders, geometry, arithmetic, mechanics, hydraulics, gnomonics (solar clocks), fortifications, perspective, and stereotomy (stonecutting).[73] In his short treatise on fortifications, geometrical tracings are used to determine the configuration, angles, and location of every element according to the regular polygon selected as a plan for the building.[74]

Although Blondel recognized the virtue of mathematics as a technical instrument, a careful examination of his work reveals his inability to distinguish between the symbolic and merely technical uses of geometry and number. In his book on the principal problems of architecture, he discusses on equal terms certain "errors" he has found in the mechanics of Galileo and the attributes of harmonic proportion. Similarly, in his *Cours,* following upon the traditional rules of proportions for the classical orders is a method for finding the dimensions of a pier or other vertical structural element in relation to the geometry of the supported arch or vault.[75] After several impressive plates that show elaborate geometrical methods for the determination of elliptical and parabolic arches, Blondel reproduced the proportions Vitruvius recommended for the design of doors and compared them to corresponding Renaissance rules.

In the *Cours,* Blondel expressed his opinion about the Dispute of the Ancients and the Moderns. He believed that both sides

Geometry as a transcendental revelation, discovered by the philosopher Aristippus after a happy landing. An allegory on the meaning of mathematics from J. Ozanam's *Récréations Mathématiques* (1696).

had good arguments. Antiquity, being the source of modern excellence, deserved to be esteemed, even venerated. But this veneration should never be slavish. Adopting a very moderate position, he concluded that "all beautiful things should be appreciated, regardless of when or where they had been produced, or who had been their author."[76] Consequently, Blondel upheld both the perfection of his own century and that of the Roman Empire.[77] And he could also admit, like Perrault, the possibility of progress in architecture.[78] But Blondel never accepted that progress was inevitably linked with an acceptance of relative values.

The fundamental problem was not, in his opinion, the greater or lesser merits of ancient and modern authors, but the absolute or relative nature of architectural value. Blondel accepted the existence of diverse tastes and appreciations of beauty, but he rejected the notion that beauty might ultimately be the result of custom. He firmly believed "with most authors" in the existence of a natural beauty, capable of producing everlasting pleasures, a natural beauty derived from mathematical or geometrical proportions. This was true not only for architects but also for poetry, eloquence, music, and even dance. The arrangement and proportion of the elements among themselves and in relation to the whole resulted in "harmonic unity," allowing the diverse parts of the work to be perceived simultaneously and without difficulty. Harmony was, therefore, the source of true pleasure.[79]

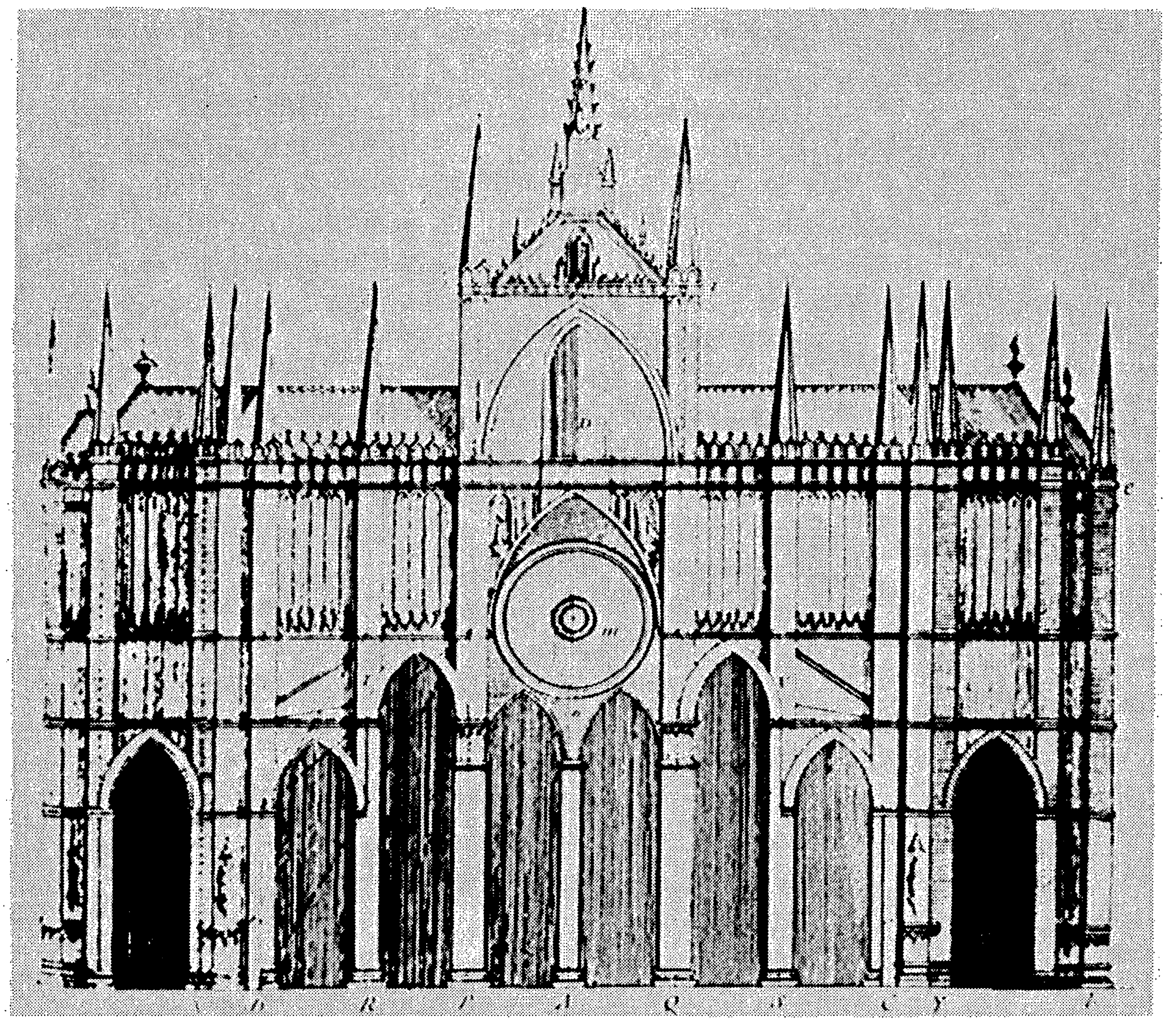
Blondel devoted a whole chapter of the *Cours* to discussing and proving the importance of proportion in architecture.[80] He collected opinions of the most prestigious Renaissance authors, espousing many of their traditional beliefs. He affirmed the existence of a profound analogy between human proportions and the dimensions of the classical orders. The proportions of buildings, therefore, could not be arbitrarily altered. Commenting on Alberti's theory, Blondel emphasized that harmony had a deep-seated relation to the human soul (*âme*) and reason. Architecture had always tried to follow the rules of nature, and "nature is invariable in all its aspects." Consequently, "the numbers that make sound agreeable to the ear are the same that make objects pleasant to the eyes."[81]

After devoting a large section of the *Cours* to proving graphically the existence of geometrical proportions in the most prestigious buildings of antiquity and the Renaissance, Blondel finally confronted Perrault's theory. Summarizing Perrault's ideas on beauty, Blondel categorically rejected Perrault's fundamental assumption that "it matters little to architects whether the beauty of a building derives from nature or custom."[82] This point, Blondel stated, is of the greatest importance and should be clarified. He then espouses the contrary opinion, sharing the ideas "of most, if not all the authors that have written about architecture."[83]

Both Blondel and Perrault believed in the unquestionable value of classical architecture. Blondel could also admit the ephemeral and mutable character of some architectural elements, such as the capitals of columns, which, in his opinion, did not derive from nature. The pleasure these elements provided was, indeed, dependent upon custom. But Blondel always believed that number and geometry, the regulating principles of nature and the embodied human being, linked both poles of the Creation and were therefore a cause of positive beauty: "External ornaments do not constitute beauty. Beauty cannot exist when the proportions are missing."[84] Even Gothic buildings, according to him, could be beautiful when they were determined by geometry and proportion. Relying on the traditional belief that our perception of the world is a projection of the human body, Blondel maintained that geometry and proportion, being transcendental entities, guaranteed the highest architectural meaning, apart from the specificity of ornament or style. For example, the bilateral symmetry in any building provided a positive delight precisely because it was an imitation of the disposition of a beautiful face or human body.[85] While Perrault believed that the systems of architectural proportion were not "true" but only "probable," Blondel's theory argued that geometry and mathematics, being invariable, assured the truth and beauty of architecture at all levels; by relating man's immediate perception of the world with absolute values, they became a tool for fulfilling architecture's fundamental symbolic role.

Also, Blondel insisted that number, in spite of its invisibility, was a primordial source of beauty: "Although it is true that there is no convincing demonstration in favor of proportions, it is also evident that there are no conclusive proofs against them."[86] Not content with a simple declaration, Blondel devoted a chapter of his *Cours* to trying to substantiate his belief scientifically. The title of this section is in itself significant: "Proofs That Proportions Are the *Cause* of Architectural Beauty and That This Beauty Is Founded in Nature, Like That Produced by Musical Accords."[87] Using as examples several well-known physical phenomena, Blondel showed how invisible causes of a mathematical nature (such as the relation between a force and the dimensions of a lever or that among angles of incidence as in reflection and refraction in optics) proved and explained effects that occurred in the real world. Applying these observations to architecture, he

The proportions in the section of Milan Cathedral, from F. Blondel's *Cours d'Architecture*.



wrote, "Experience has shown that there are proportions in beautiful buildings that we cannot find in disagreeable ones. . . . My emphatic affirmation of proportions as a cause of beauty and elegance in architecture should not be surprising. . . . Architecture, being a part of mathematics, should possess *stable and constant principles,* so that, through study and meditation, it might be possible to derive an infinite number of consequences and useful rules for the construction of buildings."[88]

Blondel, however, could not distinguish between architectural proportion and the mathematical laws of optics or mechanics. Invariable geometrical principles derived in both cases "from induction and experience." He was also unable to distinguish between the proportions of a building resulting from technical concerns and proportions motivated by aesthetic considerations. His confusion contrasts with the protopositivistic lucidity of Perrault, who, in trying to convince the readers of his *Ordonnance* that the proportions of the orders should be fixed and rational, stated that such an achievement should not be so difficult since "architectural proportions are not of the same nature as those required in military architecture or the manufacture of machines."[89] Perrault emphasized the difference between the arbitrary proportions used in architecture and the necessary mathematical strictures in other disciplines. While the dimensions of a detail of the orders could be changed without detriment to the general appearance of a building, lines of defense in fortifications or the dimensions of levers had to be absolutely fixed. Perrault distinguished speculative cause from observed phenomenon. Blondel, reflecting in a more conventional way the Baroque epistemological world view, did not recognize the difference between true physical cause and illusion, between magic and an effective technique.

Blondel realized that Perrault's theory questioned the fundamental metaphysical justification of architecture. His own refutation of an architecture that lacked absolute principles was obsessive. Three times he wrote in italics that the human intellect would be terribly affected if it could not find stable and invariable principles. Without such principles, man could have no satisfactory idea of unity and would be restless and anguished. Blondel was thus compelled to support the traditional theory of proportion, one that provided "stable and invariable principles," which in effect justified architecture's *raison d'être*. He categorically rejected relativism as a dangerous and senseless possibility.

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SYSTEMS OF PROPORTION AND NATURAL SCIENCE

The famous dispute between Perrault and Blondel touched upon a fundamental issue, one that concerned the very meaning of architecture itself. The new theory, ultimately founded on the modern mechanistic world view, was haunted by an incipient subjectivism, which caused it to question its own ability to provide absolute and rational justifications of *praxis*. I have already pointed out that during the period between 1680 and 1735, the new epistemology ushered in by Galileo was felt with particular intensity. During the first decades of the eighteenth century, architects were generally very interested in technical problems and in their mathematical solutions.[1] This protopositivistic interest generally went hand in hand with criticism of traditional theory.

In 1702 Michel de Fremin published an astonishing little book entitled *Mémoires Critiques d'Architecture*, in which he defined architecture as "the art of building according to the object, the subject, and the place."[2] Taking to their logical conclusion some of the ideas expressed by Claude and Charles Perrault, Fremin questioned, for the first time in the history of Western architecture, the traditional primacy of the classical orders. He pointed out that a knowledge of the orders and their proportions constituted only a minimal part of what architecture truly was.

Fremin's book deals essentially with problems of construction but also emphasizes that the architect is not a mason; his role is to coordinate rationally all the operations of building.[3] Fremin believed that the architect had to control mentally the totality of the process of design and construction, making sure that all he imagined possessed absolute unity and coherence. He thought that good architecture had to be rational and used Gothic examples to illustrate what he had in mind. Fremin preferred Notre-Dame or the Sainte-Chapelle over the recent Baroque architecture, which he disliked and criticized, including the work of Blondel.

Fremin was also suspicious of seductive architectural drawings that were merely nicely rendered but lacked "architectural consistency."[4] This implied an understanding of drawing as a reductive technical tool, an understanding that would only become widespread in the nineteenth century.[5] While drawing had always expressed an architectural intention, the distance between its specific universe of discourse and that of "real building" had never been a problem.

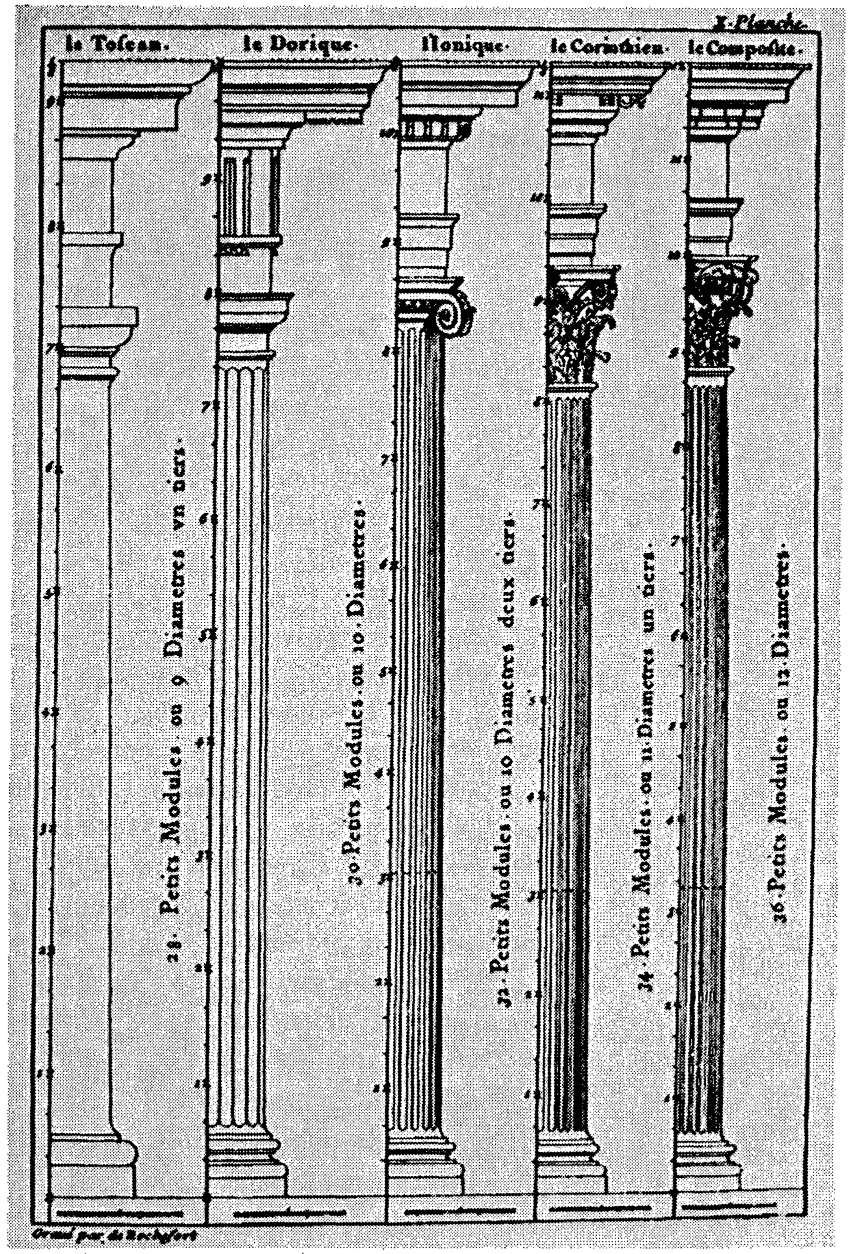
Fremin's understanding of theory, his perception "of that which constitutes true architecture," his attitude toward drawing, and his derogatory comments about "insignificant" architects who speak only about the classical orders, betray a truly protopositivistic attitude. He was totally oblivious to the metaphysical dimension of theory.

Perrault's influence appeared most explicitly in Abbé Cordemoy's *Nouveau Traité* (1706),[6] in which the defects and bad taste in most buildings are attributed to a lack of knowledge of the principles of architecture.[7] Believing that traditional treatises were useless because it was impossible to take from them the dimensions and proportions of the orders, Cordemoy praised Perrault's *Ordonnance*: "This book is the only one from which craftsmen can profit. [Perrault] provided a certain and comfortable rule for the dimensions and proportions of each order. He has even inspired the idea of beauty."[8]

Cordemoy invariably avoided any discussion of the critical questions concerning the relation between proportions and beauty. In this respect, he found Perrault "too verbose, confused, and rather obscure."[9] He never examined in his treatise the implications of proportion, except for a definition of the term that he included in the *Dictionary* added to the second edition.[10] After transcribing some opinions of Vitruvius, Cordemoy affirmed the importance of establishing a module that would allow the spectator to judge the dimensions of a building. This dimensional comparison permitted the beauty, majesty, and impact of the building to work upon the intellect. However, Cordemoy ignored the transcendental implications of proportion. He never seemed interested in establishing the actual numerical value of the module. Proportion and beauty seemed to have become problems of intellectual judgment, of relative scale rather than absolute value.

The lack of importance that Cordemoy attributed to the issue of proportion is in itself significant. He reproduced in the *Nouveau Traité* Perrault's simplified system based on the *petit module*, repeated the story about it being the most primitive, and blamed defective craftsmanship throughout history for its abandonment. Cordemoy also believed that mathematical precision was indispensable in theory. But the meaning of proportion was not even worth discussing. He seemed to be interested in the virtues of Perrault's system only as an *ars fabricandi* for craftsmen.

Perrault's immediate impact can also be discerned in the work of Sebastien Le Clerc, whose diverse interests ranged from the formulation of a cosmological system in which he tried to reconcile the Bible with Descartes's physics, to the invention of a curious theory of perception, in which only the right eye was capable of



Perrault's system of proportion, reproduced by Cordemoy in his *Nouveau Traité*.

clear vision.[11] In his *Traité d'Architecture* (1714), Le Clerc repeated Blondel's plea for all architects to learn mathematics and its related disciplines, including mechanics, leveling, hydraulics, perspective, and stonecutting.[12]

After comparing the proportions for the classical orders recommended by Vignola and Palladio, Le Clerc concluded that their rules were arbitrary, a product of their own taste and genius.[13] He also observed that it was possible to change the proportions of smaller elements such as triglyphs and metopes without offending even those most knowledgeable in architecture. Le Clerc insisted on the "absolute necessity of geometry" in architecture and described this science as the foundation of the principles that guide architectural practice.[14] Like Perrault, Le Clerc distinguished between a necessary "rational" geometry and the contingent proportions of the classical orders.[15]

Building upon these conclusions, Le Clerc decided to postulate his own system. Significantly, however, this is where the similarities with Perrault end. Le Clerc established his proportions through discussion and observation. Although there were often different proportions recommended for the same order, "it is unquestionable that among them some are more pleasing and receive universal approval."[16] He believed that his own personal taste could discern the better rules. Thus, instead of postulating an a priori mathematical system, Le Clerc thought that his rules had to be constituted a posteriori. His more humble attitude evinced no interest in controlling practice through a rational theory, and on the surface his discussion of proportions seemed merely traditional. In fact, however, his thought started to reveal a different set of epistemological presuppositions. In his theory, taste was already capable of stemming the menace of relativism while maintaining the possibility of reason—an early sign of the Neoclassical world.

Amédée-François Frezier, author of a famous treatise on stonecutting, was a long-lived architect and military engineer.[17] Interested in science and construction, he was aware that geometry and mathematics were the basic disciplines providing the means for the implementation of technical operations. For Frezier, architecture was mainly a problem of rational building, and in several literary disputes with the most famous Neoclassical theoreticians, he argued that arches and piers were more suitable for stone construction than the column and lintel systems preferred by the architects and patrons of the Enlightenment.[18] It is particularly interesting, therefore, to observe the way in which he interpreted Perrault's ideas in his *Dissertation sur les Ordres d'Architecture* (1738).

Frezier recognized along with Perrault that there were no fixed rules in architecture. Ornament changed constantly, and therefore "it has no real beauty."[19] He admitted that "fashion reigns over the classical orders" and that it often determined our idea of beauty. But unlike Perrault, he never accepted custom as a positive force: "Fashion is not always a certain rule for judging what is beautiful or deformed."[20] Custom no longer determined a choice of proportions, which were then identified with "positive beauty" through association. Instead, it became a negative factor that prevented the appreciation of true natural beauty.

Frezier believed that the classical orders should be strictly subjected to rational laws, which could guide architecture toward "purely natural beauty."[21] And he believed it was possible to establish such rational principles, independent of the diversity of personal tastes and opinions: "Everyone would accept that the imitation of a natural thing is a cause of pleasure . . . and being perfect, a copied object derived from a beautiful nature is a cause of even greater pleasure than the original. . . . If it exists, the universal rule of the orders should be founded on the imitation of Natural architecture."[22] The point was, in Frezier's opinion, to establish the principles of this "great art . . . which has often even been called a science" and to obtain them from the most simple things. This, in turn, would lead architecture back to its origins. Natural architecture was simple, like Nature itself in eighteenth-century science.

After an evocation of primitive architecture taken from Vitruvius, Frezier discussed the appropriate number of architectural orders.[23] Inspired by the methods of natural philosophy, he declared his intention to reduce the number of principles to the least possible. Acknowledging only three ways to build: heavily, lightly, or in an intermediate manner, he concluded that there should also be only three orders: Doric, Ionic, and Corinthian. The Tuscan and Composite, normally accepted since the Renaissance, were rejected.

Frezier believed that man had a natural idea of the proportions between the dimensions of a column and the weight it carried. It was obvious that columns more squat than Doric or taller than Corinthian could be built. But the former lacked "grace," while the latter, although perhaps physically stable, would appear as dangerous and thus be unacceptable to the human intellect. Building should possess not only real stability but also "visible solidity."[24]

With this in mind, Frezier applied his natural common sense and experience to the determination of the maximum and minimum acceptable proportions and attributed them to the Doric and Corinthian orders. The proportions of the Ionic order were obviously the *juste milieu* between the two extremes and resulted from an arithmetical average of their dimensions. Frezier pointed out that in applying this system, it becomes possible to determine the proportions of the essential parts of each order: the column and the entablature. The greater weight should always be carried by the wider columns. But the adjustment of dimensions, he added, should be left to the good taste of the architect.[25]

Discussing the issue of proportion, Frezier recognized the great differences among traditional systems. Architects had chosen diverse modules, dividing their dimensions in extraordinarily complicated ways. However, Frezier questioned the "scientific" thoroughness of his predecessors, suggesting that perhaps their irrationality was intentional, "as if they had tried to complicate this frivolous issue and give an air of mystery to this art, which is almost totally arbitrary in that concerning the small subdivisions."[26] Frezier thus rejected the inveterate symbolic connotations of architectural proportion, maintaining that the dimensions recommended by architects and writers of the past were based only on their particular tastes. Numerical relations, then, did not constitute a mysterious guarantee of architectural beauty.

Like Perrault, Frezier believed that the "causes" of beauty should be visible and not merely speculative. But Perrault had postulated an a priori, mathematically perfect system of proportions, emphasizing its formal rather than its transcendental dimension. This, of course, was the only possible scientific solution to the problem in the epistemological context of the late seventeenth century. During the Enlightenment, however, the meaning of life itself would become visible in the operations of Nature, as revealed by the new empirical science. Frezier could therefore assert that the principles of architecture should be founded on the laws of nature and stem invariably from observation and not from a merely conceptual operation.

Thus Frezier established the essential proportions of his three orders, defining the relations among the heights of columns, their diameters, and the dimensions of their entablatures.[27] His proportions were simple, but they were never intended to become a mere tool of design. They were not arbitrary but natural and were therefore believed to be the most perfect, constituting a true source of pleasure. Even with regard to minor details, Frezier ended up admitting the existence of proportions, "which it is not possible to alter considerably."[28] The dimensions of doors and windows, for example, cannot be changed because their beauty "derives from a natural sentiment through which we relate everything to the dimensions of our body and to our needs, even before reason has determined their convenience."[29] To prove his point, Frezier stated that if humans had the proportions of sheep or birds, they would prefer square or circular openings. But because humans are approximately "three times as tall as . . . wide," these are the proportions that are considered beautiful. This phenomenological return to reality, with its emphasis on preconceptual perception as a fundamental source of meaning, would become normative in the natural philosophy of the Enlightenment.

Frezier provided an excellent summary of his own position when he declared himself "only partially (*de moitié*) in accord with Perrault on the insufficiency of proportions as a source of real beauty."[30] His theory of architecture, founded on the epistemological framework defined by eighteenth-century empirical science, sought to recover an explicit, traditional interest in absolute value (identified with mathematics) while accepting without contradiction the increasing power of reason.

A similar attitude was adopted by Père André in his influential and popular *Essai sur le Beau* (1741). André believed there were two types of rules in architecture: (1) rules that were necessarily equivocal and uncertain, resulting from the observations of diverse masters in different times; and (2) rules that were visible and conducive to positive beauty. André thought that the proportions of the classical orders were in the first group, but he also stressed the geometrical character of the second type of rules, which were "invariable like the science of architecture itself."[31] Essential geometrical principles, such as the perpendicularity of columns, parallelism of floors, symmetry, and perceptual unity, were always to be observed. In fact, André considered all regularity, order, and proportion to be attributes of essential beauty.

As the century grew older, Perrault's precocious distinction between technical necessity and contingent aesthetic considerations seemed to vanish from architectural theory. The dimensions of number and geometry as technical instruments or symbols began to be perceived as complementary in considering architectural value. Around 1750 preference for François Blondel's position in the famous dispute was practically universal, whereas Perrault's ideas often evoked criticism. The most explicit refutation of Perrault's theories appeared in Charles-Etienne Briseux's *Traité du Beau Essentiel* (1752), which sought to show the falsity of Perrault's ideas through the opinions of prestigious writers and evidence derived from "physical explanations and experience."

Briseux accepted that progress in art and science was prompted by a healthy expression of diverse opinions, but he believed extreme subjectivism was dangerous. An obstinate adherence to a certain position, "frequently motivated by the false honor of defending a singular system," often makes men lose sight of their own internal convictions.[32] Briseux speculated that Perrault's defense of a system of proportions "that had absolutely no relation to the beauty of buildings" might have been prompted by such human weakness. In Briseux's opinion, Perrault, perhaps offended by Blondel, had become insensitive to his own knowledge, the opinions of other authors, and the unquestionable evidence of experience. What caused him the most concern was the vast influence he thought the *Ordonnance* had exerted on other architects. Significantly, Briseux was aware that Perrault's system of proportion never became popular with eighteenth-century practicing architects. The issue was not simply one of immediate application. Briseux understood that the potential freedom from traditional principles, implicit in Perrault's theory, had made itself felt during the first half of the century. The ornamental exaggerations of Rococo, popular after 1715, were a clear manifestation of this influence.[33] Distinct from Baroque architecture (though certain formal similarities remain), Rococo eschewed theory. Only pattern books were used as sources of images. Taking their cue from Perrault, some architects felt themselves liberated from the authority of antiquity and resorted to a superficial, purely visible understanding of nature as a source of forms. By midcentury the nonmetaphysical nature of *rocaille* had been replaced by the Nature of Newtonianism, of which more will be said later. At this point, Rococo was universally condemned as decadent by the theoreticians of Neoclassical architecture.

The impact of Perrault's incipient *ars fabricandi* was also felt in the Royal Academy of Architecture, where discussions during the first half of the century dealt mainly with technical questions. This obviously reflected the general interest of architects and caused Briseux to complain that the true "principles of architecture" were no longer taught by professors who followed the banner of Perrault.[34] Briseux considered the *Ordonnance* to be exceptionally obscure and full of contradictions. His refutation seems traditional at first glance. He asserted the analogy between the causes and effects of beauty in architecture and music and carefully justified his belief. In music, the harmonic relations, although not generally understood by the public, were nevertheless the source of pleasure. Equally, in architecture, the observer did not measure "geometrically" the building with his eyes before receiving the "sensation" of beauty. But "a sort of natural trigonometry" seemed to play a large role in the judgment of "the spectator who possesses a natural taste."[35] "The sensation of beauty" always depended on the observance of proportions, whose knowledge was the responsibility of the architect.

Briseux firmly stated that reason underlined all those products of "art and Nature" that were beautiful. This is an indication of Briseux's fundamental belief in a transcendental Nature and in the absolute character of its laws. His *Traité* attempted to prove the visibility of harmonic proportions in architecture and to show their origin in the mathematical laws that governed nature itself. Such proportions might then be said to be "analogous" to the human intellect, which perceives them with pleasure, and thus be posited as the unquestionable cause of essential beauty.

Briseux's text begins with a poetic glorification of Nature, "our fecund mother that leaves nothing to chance."[36] Nature is described as a projection of the human body, the ultimate model of just proportions, providing the true idea of harmony and symmetry. Harmonic proportion, moreover, had its origin in nature. The famous experiments of Pythagoras, who had subdivided a string into fractions producing harmonic consonances, clearly proved this point. Briseux then related how the ancients "inferred" from this observation a common principle of beauty, one that derived from the law of harmonic proportion, which was itself part of nature and did not depend on the visual or auditive character of our sensations. The human intellect, the judge of all "sensations," thus received from each of the senses uniformly pleasant or disagreeable "impressions".

But it was clear to Briseux that "the Creator established a natural sympathy between certain sounds and our emotions" that was not as explicit with regard to the inanimate objects of the visible world. The traditional justification of antiquity no longer seemed sufficient. Briseux was then forced to reformulate the question of this relation in a more rigorous and scientific manner. His conclusions reveal the most fundamental sources of his thought: "The rainbow provides an excellent example; its colors are clearly distinguishable, but everything is reduced to unity. According to the experiments of the renowned Newton, this marvelous effect originated from the correspondence between the proportions of the spaces occupied by the seven colors and that which regulates the intervals between the seven musical tones: a natural 'tableau' that the Creator offers to our eyes, in order to initiate us in the system of the arts."[37]

By invoking the name of Newton, Briseux hoped to give legitimacy to his "intuitions." It was evident that Nature always operated with the same wisdom and in a uniform manner. Therefore no one could question that both auditive and visual pleasure consisted "in the perception of harmonic relations analogous to our human constitution" and that this principle was true not only for music but for all the arts since "one same *cause* cannot have two different *effects*."[38]

Briseux also stressed his rejection of Perrault's distinction between the specific characteristics of visual and auditive sensations from the point of view of the subject: "The mind is touched in a uniform fashion by all commensurable objects."[39] This is significant because both Briseux and Perrault clearly shared the notion of perception *partes extra partes*, understood as an intellectual association of sensations transmitted by independent, specific senses. But Briseux, believing in the existence of a mathematical structure that linked the external world with the human intellect, could "recover" the primordial sense of preconceptual, embodied, and undifferentiated perception: "The mind judges all types of impressions in a similar and uniform way, this being an indispensable necessity, a sort of law that has been imposed by Nature."[40]

Briseux may not have fully appreciated the importance that proportions and arbitrary beauty had in Perrault's system.[41] However, his main criticism was perfectly valid in his own epistemological context. Perrault's proportions were not derived from the observation of nature, and so his system was despised by most architects precisely because it was totally intellectual and a priori. This explained, in Briseux's opinion, why Perrault's relatively small variations had "visibly altered the beauty" of the classical orders.

Briseux accepted the existence of a diversity of tastes, but he always reconciled any divergences with his belief in an absolute beauty that depended on "geometrical principles" and was derived from Nature. He thought that the rules of proportion, founded on "calculation" and "experience," constituted invariable principles that allowed the architect to "operate justly" and were indispensable for perfecting his innate talent: "In vain have the followers of Perrault pretended that there are no rules but those of taste."[42] On the other hand, Briseux emphasized that it was not sufficient to follow certain theoretical proportions literally in order to design a meaningful building. The architect's taste, perfected through experience, was ultimately responsible for the appropriate choice of dimensions. Taste was not synonymous here with pure, arbitrary subjectivity. It was perceived by Briseux as capable of correcting any conceptual system, including Perrault's. Resulting from experience and the observation of Nature, it had a transcendental and intersubjective character, and was thus incapable of distorting the true natural systems of proportion.

In sharp contrast with the intentions of Perrault's *ars fabricandi*, Briseux never pretended to reduce practice to theory. This is evident in the second volume of his *Traité*, where he illustrated his harmonic proportion applied to the classical orders without the use of numerical dimensions. Briseux merely drew graphic scales along buildings and elements of the orders demonstrating the existence of dimensional relations. He did not provide specific measurements or a module that might allow the translation of any illustration into a building. It is clear that his theory deliberately kept a distance from practice. Unquestionably, Briseux understood the values of the latter, which accounts for the apparent contradiction in his statements about taste. True taste was a warrant of architectural meaning at the level of practice, and Briseux's theory was an indispensable complement and guide, not a substitute. The role of theory as a justification of practice prevails here over its utility as a technical instrument.

Other architects and theoreticians during the second half of the eighteenth century adopted similar attitudes. Germain Boffrand, for example, believed that although acceptable buildings might be constructed without using the orders, proportions were absolutely indispensable.[43]

Boffrand, a member of the Royal Academy of Architecture and the successor of Jacques Gabriel in the leading post of the *Corps des Ponts et Chaussées*, published in 1745 his *Livre d'Architecture* along with an interesting technical study on how to cast in one piece a bronze equestrian statue of the king. Interested in a wide variety of technical and artistic subjects, including machinery, the centering of bridges, lock construction, methods of mensuration, and Gothic and Arab architecture, Boffrand, like François Blondel, attributed the beauty of some Gothic buildings to their just proportions. For him, the most important function of the architect was to choose appropriate rules of proportions. He thought that nature formed the germ of the arts, but that reflection and experience nurtured it and allowed it to develop. "Perfection derives from an excellent imitation of the *belle Nature*", which was also the origin of the principles of Greek and Roman architecture. Ancient models could, therefore, become once again a legitimate source of meaning.

Boffrand's small treatise examines certain relations between the classical orders and the different styles and genres described by Horace in his *Art Poetique*. His analogy was still clearly metaphoric. Architecture was a poetic activity in the sense of Aristotle's *poesis*, an action with transcendental objectives, determined by an implicit thrust to reconcile man with a cosmic order. Boffrand's primitive semiological study, however, stemmed from a belief that, once divorced from metaphysical concerns, would become the very source of modern structuralism. The fundamental point of departure for his work was the identity between the principles of the arts and those of the sciences, both of which are founded on mathematics and geometry. Geometry, he thought, could be applied to any science, so that "a study of one subject can bring new knowledge to another."[44]

The abbé and *homme des lettres* Marc-Antoine Laugier, the most influential theoretician of French Neoclassicism, also believed that architecture should have as sound principles as does science.[45] In the preface of *Essai sur l'Architecture* (1753), Laugier rejected the notion of a theory reduced to an *ars fabricandi*. He stated that in all those arts that are not purely mechanical like architecture, it is not sufficient to know how to proceed; the author should learn to think. An artist should be able to explain to himself why he does what he does: "For this reason, he needs fixed principles to determine his judgments and justify his choices."[46]

Laugier maintained that architecture had never been founded on true, rational principles. Vitruvius and all his modern followers, with the exception of Cordemoy, had only recounted the practices of their own times, but had never penetrated the mysteries of architecture. To Laugier, practice often misleads artists from their true objectives: "Every art or science has a definitive objective. There is only one way of doing things right."[47]

In order to establish "evident" principles that could be the basis of invariable precepts for practice, Laugier adopted an empirical method. He used "experiments" and observations to ascertain that the most beautiful buildings and objects produced the same positive or negative impressions on himself and others. After repeating these experiments a number of times, he became convinced that there were essential beauties in architecture, independent of custom and convention.[48]

Laugier was an eminent historian, so confident in his rational judgment that he could criticize the traditional political status quo.[49] He openly admitted his faith in the progress and evolution of architecture. But the abbé also believed that his *Essai* contained infallible and truly fixed rules, and that his efforts to discover "the causes of the effects" produced by certain famous and beautiful buildings were totally successful. Laugier's *logos* was certainly rigorous and inquisitive, thoroughly shaping his theory, but never betraying a superficial interest in formal or technical control. His fundamental concern was to disclose the possibilities of meaning in an activity that appeared increasingly in crisis because of its lack of principles but that was, according to him, crucial for the coherence of culture. Following from his premise that there was meaning in the world (*Nature*), Laugier aspired to understand the act of creation, and thus looked back to the origins of architecture. The final answer to his metaphysical question was necessarily a myth.

In the first chapter of his *Essai*, he described the essential elements of architecture that can be derived from the primitive hut: the architecture of man in an idyllic, unprejudiced, and natural state. The columns, architraves, and pediments that constituted the hut were put forward as the *only* essential elements of architecture. During the earlier part of the century, architects and engineers had been more aware of the differences between the values of *firmitas* (physical stability, durability) and those of *venustas* (beauty). Before Perrault, this fragmentation of value had never played a role in architecture.[50] Striving to save meaning, Laugier emphatically identified the fundamental parts of the classical orders (ornament in Renaissance theory) with the very structure of the building. In spite of his differences of opinion with Frezier regarding what constituted the most rational form of construction, this attempt to reconcile the traditional values responded to the same concerns that the military engineer had first revealed in his *Dissertation*.

Frontispiece of Laugier's *Essai sur l'Architecture,* showing the primitive hut as a source of architectural principles.

The great impact of Laugier's *Essai* has been widely studied.[51] His "essential elements" became the favorite forms of Neoclassical architecture, and his ideal church was obviously the germ of Soufflot's project for Sainte-Geneviève, later to become the French Pantheon. But Laugier also published some twenty years later a second book, *Observations sur l'Architecture*. In this less popular text, he upholds the fundamental importance of proportions; this is so essential to architecture that, in his opinion, a well-proportioned building will always produce a positive effect, independent of the richness of its materials or ornamentation.

In the *Essai*, Laugier criticized Briseux for having invested so much effort only to prove a self-evident truth. No one with a minimum of knowledge about architecture would deny the necessity of proportions.[52] Furthermore, Laugier thought that Perrault had understood the absurdity of his own argument and defended it only out of stubborness, while Briseux, in his opinion, would have fared better if he had tried to discover and postulate rational rules of proportion.

This is precisely the task Laugier undertakes in his *Observations*. His objective is to establish the "science of proportions" on more solid grounds. A precise rational operation always has to be involved in the choice of dimensions; rules of proportion must be applied to not only the classical orders but many aspects and parts of a building. Laugier was critical of previous authors who had merely copied Vitruvius in their systems of proportion without pondering their importance. He himself wished to provide an adequate justification of proportions, "raising slightly the thick curtain that hides this science."[53]

His text is a rational tour de force that tries to establish a theory of proportion based exclusively on "visual" evidence. Three criteria of judgment are put forward: The first essential requirement for a correct proportion is the "commensurability" of the two compared dimensions, the exactness of their correspondence. The second requirement is "sensibility" and refers to the ease with which the relationship can be perceived, 3 : 5, for example, being better than 23 : 68. The third category is the "proximity" of the proportional relation to the perfect ratio (1 : 1); 10 : 30 is worse than 10 : 20. There is no further rational justification with regard to the choice of proportions. Numbers have to be simple and natural. Most important, however, was Laugier's belief in the essential character of dimensional relations generating meaning in architecture. Proportion, like the essential formal elements of his *Essai*, is ultimately derived from an ordered and harmonious nature whose *mathemata* could be evidently perceived by man.

After Laugier, the contradictions between taste and reason, which had been posited earlier in the century by Cordemoy, Briseux, and the abbé Dubos, were thoroughly reconciled.[54] They both, of course, were derived from Nature. Defending his position from the criticism of Frezier, who had brought up the issue of arbitrary beauty in a review of the *Essai*, Laugier categorically pointed out that there was an essential beauty in art, often difficult to define by reason, but absolutely evident to our hearts and perceptions.

The notion of simplicity as a source of beauty underlined architectural intentions during the second half of the eighteenth century and appeared in many theoretical works. In his *Traité des Ordres d'Architecture* (1767), one of the last manuals of this type ever published, Nicolas-Marie Potain declared his intention to elucidate the origin of the five orders, which are "derived from one common principle."[55] He adopted the prototype of the primitive hut and postulated it as a model for both the essential formal elements of architecture and his own system of proportions. Also, several scientists and philosophers of that period referred to architectural proportion in terms similar to Laugier's, for example, Christian Wolff, whose contribution will be examined in the following chapter, and Leonard Euler, the exceptional mathematician who determined the equations for the buckling of columns long before this phenomenon could be tested experimentally. In his *Letters to a German Princess*, Euler discussed musical harmony, rejecting its cosmological implications. However, he still thought that natural proportions, expressed in small numbers, were more clear to the intellect, thereby producing a feeling of satisfaction. He maintained this was the reason why architects always followed that norm, using the simplest possible proportions in their works.[56]

Compared to philosophers and *hommes des lettres* such as Wolff or Laugier, engineers and architects of this period obviously were more interested in technical problems. But the differences in interest should not hide the profound similarities of their theoretical assumptions. Jacques-François Blondel, the most important architectural teacher in France around midcentury, still conceived of architecture as something of a universal science. In 1739 he instituted a school of architecture, independent of the Royal Academy of Architecture, which taught that the architect should be knowledgeable in science, philosophy, literature, and the fine arts.[57] And while accepting the differences between naval, civil, and military architecture, Blondel praised the achievements of Frezier, François Blondel, and Vauban, all simultaneously architects and military engineers.

Jacques-François Blondel's ambition may have seemed unwarranted at a time when the first specialized schools of civil engineering (*ponts et chaussées*) and military engineering (*génie militaire*) had already been established in Paris and Mezières. What is significant, however, is the great number of similarities between the program of studies at Blondel's school and the curriculum of the two technical institutions.[58] Blondel's course actually became a requirement for admission to the *École des Ponts et Chaussées*.[59] It included, aside from the theory of architecture, the history of proportions, drawing, ornament, and sculpture, many technical subjects, such as mathematics, geometry, perspective, topography, mensuration, and the properties of the conic sections necessary for stereotomy. In his *Cours d'Architecture*, a vast work that summarized his pedagogical career, Blondel added other subjects to the list, such as mechanics, hydraulics, trigonometry, principles of fortification, and experimental physics "relative to the art of building."[60]

In the first volume of his *Cours*, Blondel emphasized architecture's usefulness, claiming it as the basis of all works that physically transformed the world of man. Not only temples and public buildings but also bridges, canals, and locks fell within its province. Throughout the eighteenth century, engineers and architects still shared a theoretical framework and a basic intentionality derived from common principles, so that their individual areas of action were not mutually exclusive. Many civil and military engineers such as Gauthey and Saint-Far frequently built churches and hospitals. Gauthey, the author of an important book on the structural analysis of bridges, also wrote about architecture and adopted Laugier's principles.[61] Perronet, a renowned civil engineer and founder of the *École des Ponts et Chaussées*, was also a member of the Royal Academy of Architecture. In a similar position was the mathematician Camus, who wrote his *Cours de Mathématiques* for the students at the academy and then saw his text adopted by the military schools.

Jacques-François Blondel's extensive *Cours* pretended to be the first truly universal encyclopaedic work on architecture. The similarity with the aims of the *philosophes* is, of course, not coincidental. Blondel admitted that except for the problem of distribution, all that could be considered as essential in architecture had been discussed previously. His text is basically a compilation and systematization of the most important and prestigious theories of the past.

In the second volume of his *Cours*, Blondel systematically studied the "distribution" in plan of different types of buildings (*genres d'édifices*), such as Greek cross, Latin cross, and centralized churches, cathedrals, markets, and convents. He was fascinated by room combinations and their relation to land use. An interest in typology led him to write the first consistent exposition on the subject in Western architecture. In contrast to nineteenth-century formulations, his types never referred exclusively to utilitarian or formal categories. His general eclecticism notwithstanding, Blondel never affirmed that the value of a building might result simply from the appropriate distribution or combination of its parts in plan.

Blondel recounted in a traditional way the story about the mythical origin of the classical orders and reproduced the proportional systems of Vignola, Palladio, and Scamozzi. His understanding of fashion was very confused, but in the end, he also considered taste as a positive criterion for the appreciation of beauty. Natural taste, although innate, could be perfected through the comparison of great master works, "becoming a banner to guide artists in all their productions."[62]

Blondel often stated that the problem of proportion was the most interesting part of architecture.[63] In his *Cours*, he tried to prove that architectural proportions were derived from nature, citing the opinions of great masters. Although he could understand the differences between visual and auditive sensations, he still believed in the analogy between architectural proportion and musical harmony. Without mentioning Perrault by name, Blondel criticized "those authors that have considered proportions as useless, or at least arbitrary." Basing their theories on independent systems, these authors rejected fundamental laws and traditional principles, pretending that there were no convincing demonstrations in favor of architectural proportions and that a lack of innovation was synonymous with timidity. After measuring many beautiful buildings, Jacques-François Blondel repeated in almost identical words the original refutation of François Blondel, concluding that the source of true beauty in architecture consisted essentially in proportional relations, "even though it might not be possible to prove [this] with the scrupulous exactness of advanced mathematics."[64]

In his *Architecture Françoise* (1752), Jacques-François Blondel tried to show how the most pleasant proportions could be determined from a comparison of the best existing buildings. In attempting to rationalize the problem, he established three different types of proportion. The first was derived directly from human dimensions, such as the measurements of a step; the second referred to the structural stability of a building, prescribing, for example, the thickness of walls; and the third was concerned with beauty, being applied particularly to the classical orders.[65] J. F. Blondel's types of proportion correspond to each of the traditional Vitruvian categories: *commoditas*, *firmitas*, and *venustas*. His lucid distinction contrasts sharply with the confusion between the aesthetic and technical attributes of proportion in François Blondel's Baroque theory.

Nevertheless, J. F. Blondel always maintained that architecture had access to the sphere of absolute values. He thought beauty immutable and felt that architects, through their open spirit and sense of observation, were capable of extrapolating it "from the productions of the fine arts and the infinite variety of Nature."[66] He believed that excellent buildings possessed "a mute poetry, a sweet, interesting, firm or vigorous style, in a word, a certain *melody* that could be tender, moving, strong, or terrible."[67] Just as a symphony communicated its character through harmony, evoking diverse states of nature and conveying sweet and vivid passions, so proportion acted as the vehicle for architectural expression. Properly used, it presented the spectator with "terrifying or seductive" buildings, allowing for a clear recognition of their essence, be it "the Temple of Vengeance or that of Love."[68]

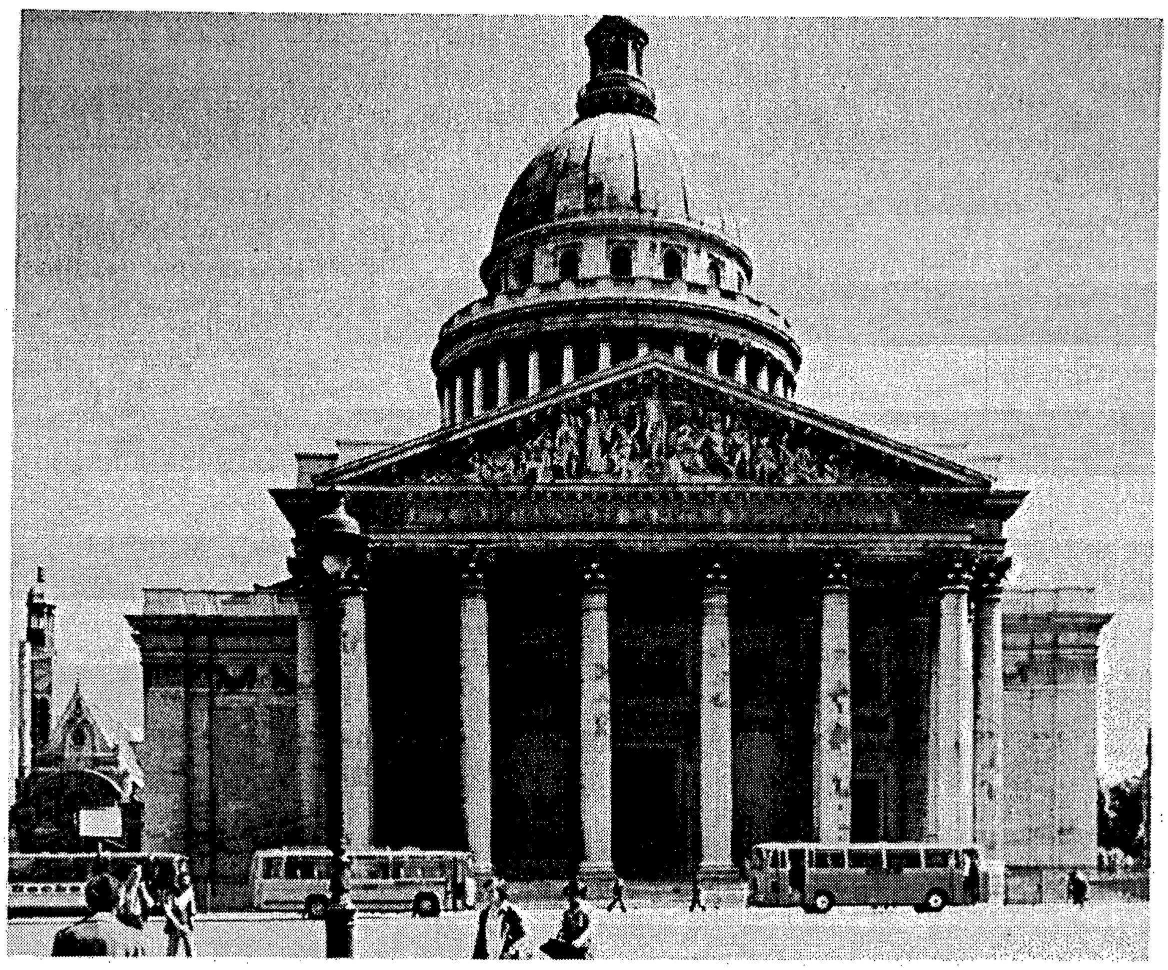
In an age when enlightened reason was capable of questioning the absolute validity of the forms of classical architecture, the problem of meaning appeared more clearly at the level of theory. For Blondel however, it was never reduced to the issue of evidence of style or type; it was primarily a problem of reference. Blondel believed that "it was ultimately unimportant whether our buildings resembled those of classical antiquity, the Gothic period, or more modern times," as long as the result was happy and the buildings were endowed with appropriate character.[69] Naturally, the expressive and poetic character of architecture was guaranteed by proportion.

The crucial reconciliation between aesthetic and technical interests to which I have previously alluded is particularly evident in the work of Jacques-Germain Soufflot,[70] whose most significant creation, the church of Ste.-Geneviève, represents the culmination of French Neoclassicism, embodying that taste that admired the lightness of Gothic structures and the purity and grace of Greek architecture. In this building, it is impossible to establish where aesthetic motivations end or at what point design decisions were prompted by an intention to rationalize the structural system. In his constant participation in academic deliberations, Soufflot displayed an interest in geometry, mechanics, geology, physics, and chemistry.[71] His best friends were famous engineers like Perronet and Rondelet. Soufflot also designed a machine to test the quantitative strength of stone. His scientific observations were instrumental in determining the proportions of Ste.-Geneviève, particularly the dimensions of the structurally critical central piers under the dome.[72] He defended the daring dimensions of his structure, claiming that they had been established through observation and experimentation. In 1775 he proposed to the Royal Academy of Architecture the construction of other machines to determine the strength of metals and wood. These machines, he thought, should be made easily accessible to architects and engineers.

All this notwithstanding, Soufflot wrote two formal papers on the problems of taste and proportions. His work on the identity of taste and rules in architecture was initially presented to the academy at Lyons in 1744, and read at least twice in the Royal Academy in Paris during 1775 and 1778.[73] According to Soufflot, there existed a reciprocity between taste and rules in architecture; taste had been the original source of rules, which, in turn, modified taste. Rules have always existed; the Greeks simply discovered them. Taste and rules were found in Nature, but they could also be taken from excellent authors. "A force whose cause I ignore," writes Soufflot, "always leads me to the choice of proportions. I build accordingly; my work pleases and becomes a rule for those that come after me." If greater assurance was required, Soufflot recommended precise measurements of beautiful buildings and a careful consideration of the effects produced by their proportions.

Soufflot believed architecture should be simple and guided by the "beautiful correspondence among the parts of the human body." Like Père André a few years before him, he affirmed the existence of an essential geometry, which could be perceived empirically in nature and that was the origin of true beauty. Architecture was bound to respect these universal rules, such as the observation of horizontal and perpendicular lines and the disposition of weaker over stronger elements.

The church of Sainte-Geneviève in Paris, transformed after the Revolution of 1789 into the French Pantheon.



Soufflot's theory again reflects the fundamental paradox of eighteenth-century epistemology: Architectural rules can be determined empirically through taste only after one has accepted the premise of a universal, immutable architectural value to which natural observation has access. Ignoring the relation between cultural or historical context and architectural expression, particularly explicit after the publication of Johann Bernhard Fischer von Erlach's universal history of architecture (1721), Soufflot rejected formal invention: "What was beautiful two thousand years ago is still beautiful." True beauty, in his opinion, was not "an extravagant composition of ornament." Consequently, he disapproved of rococo, baroque, and medieval complexities. Beauty consisted "in a perfect disposition of the most common parts" whose forms and proportions were perfectly known already. The role of the architect was to combine and establish dimensional relations between these absolutely valid classical elements, which would constitute the specificity of each work, its true source of meaning.

In his *Mémoire sur les Proportions d'Architecture* Soufflot discussed the dispute between Perrault and François Blondel.[74] Like Laugier, he questioned the authenticity of Perrault's conviction; both architects, in spite of their differences, had obviously created beautiful buildings. But Soufflot, while admiring Perrault's facade for the Louvre, unhesitatingly sided with Blondel. He thought natural proportions did exist, differences among specific examples notwithstanding. Discrepancies, after all, were the product of optical correction and adjustments. After measuring many famous churches, including some Gothic structures, Soufflot concluded that their general proportions were approximately the same, a product of nature, not custom, and, as in music, constituted a true cause of pleasure.

Soufflot was well aware of the works of Galileo and was capable of using mathematics as a formal instrument in his speculations about statics and structures. His predilection for quantitative experimental results in problems of strength of materials and his ability to disregard the experience embodied in prestigious buildings of the past and the authority of famous architects seems to betray the attitude of a positivistic engineer. The truth, however, is that Soufflot's positions in relation to both aesthetics and mechanics were derived from a belief in a mathematically ordered nature. Scientific observation and experimentation yielded quantitative results that led to the establishment of absolute laws. In a similar way, a transcendental taste had access to the rules of proportion implicit in the same elemental Nature; architecture, a metaphor of divine creation, should therefore be simple and thoroughly ruled by number. And the truth and beauty of any building were endorsed by the presence of number.

Soufflot's most severe critic was Pierre Patte, also an architect and prolific writer, who was mainly interested in the technical problems of building.[75] In the introduction of his most important work, *Mémoires sur les Objets les Plus Importans de l'Architecture* (1769), Patte emphasized that except for the problem of proportion, on which there was no universal consent, the remainder of architecture still needed to be expounded. In his opinion, the most essential, useful, and necessary part of architecture was construction, which still lacked principles. This aspect, Patte conceded, had been traditionally understood by masons. But it was imperative to study its principles in a more profound way "from a philosophical point of view."

Among the many chapters devoted to clarifying technical problems of architecture and urbanism, there is one that addresses the proportions of the classical orders. Patte does not question the fact that "proportions constitute the essential beauty of architecture," and in an earlier work he had drawn a connection between proportion, character, and morality.[76] He thought that beautiful buildings ruled by proportions would inspire noble and even religious feelings. The problem was to determine what these proportions actually were. Patte was convinced that if this became possible, architecture would achieve perfection.

He rejected outright the ancient metaphoric identification of columns with the human body, relating the former to the "disposition" of trees. Repeating Frezier's argument, he replaced the Vitruvian myth of the genesis of the classical orders with a theory based on the intuitive mechanics of primitive building. According to Patte, the Egyptians had used very heavy columns; it was the Greeks who gave columns a thickness relative to their heights and to the loads they had to bear. Thus, he thought, were established the natural proportions of the orders. But here begin the problems. Like Perrault, Patte worried about the discrepancies between theoretical systems of proportion and the dimensions of real buildings. Even during Vitruvius's lifetime these problems existed, and all subsequent attempts to reconcile the differences had failed. Patte attributed this failure to the lack of absolute rules of proportion, which architects had never been able to establish. Two great difficulties existed: finding principles leading to self-evident or at least probable truths, capable of satisfying both taste and reason, and the impossibility of subjugating the human intellect to determinations whose principles were not derived from nature.

Patte thought that the architect faced problems similar to those of an artist trying to determine geometrically exact relations between the features of a beautiful face. The mathematical law existed; the problem was to discover it from the observation of nature.

From this point of view, Patte devised a devastating criticism of Perrault's *Ordonnance*. Acknowledging Perrault's intention to "reconcile the differences between theory and practice, " Patte maintained that Perrault had failed. He attributed this failure to his predecessor's belief that neither reason or good sense nor the imitation of nature constituted the foundation of beauty. Patte's interpretation of Perrault's ideas is peculiar and significant. Perrault's understanding of proportion as arbitrary, dependent solely on custom, amounted in Patte's opinion to an absolute negation of the existence of positive beauty in architecture.[77]

Perrault had tried to justify his new rational system by identifying it with a mythical, perfect, ancient system that had been ruined by the carelessness of craftsmen throughout history. Patte never took this claim seriously. He thought Perrault's theory was only an extreme example of what had always happened in architecture, perpetuating the discrepancies between theory and practice. But Patte agreed with Perrault in his assessment of optical corrections. It was absurd to pretend, like Blondel had, that true beauty might be derived from those adjustments. Thus Patte emphasized the modern intention to establish a fixed and immutable system of proportions capable of controlling practice.

Both Patte and Perrault shared a concern to solve the problem of architectural proportion through scientific method. The great differences between them corresponded precisely to their divergent beliefs regarding the origin of knowledge in science and its accessibility. Patte declared that instead of trying to establish new, ideal systems, inevitably condemned to fail, it was preferable to define methods for the determination of optimal proportions through practice. Only then would it be possible to postulate a truly rigorous system, capable of reconciling different opinions in one rational whole. Patte believed that Perrault's system was erroneous and had never been used because "it was false that a proportional mean could produce in any case the most agreeable effects, coinciding with true perfection."[78]

Patte distinguished, as did Perrault, between observed phenomena and speculative causes. Nevertheless, he rejected the possibility of inventing a priori systems, choosing instead the empirical method of natural philosophy. While both authors wished to define the mathematical principles of architecture, Patte was the more patient. He repudiated the Platonism of Perrault and insisted that proportions should be derived from nature. Numerical relations were assumed to be visible. For Patte, then, numbers recovered their transcendental dimension and could be postulated as the fundamental means for the imitation of nature, still architecture's task.

The system that Patte finally put forward after his rigorous scientific disquisition was, perhaps not suprisingly, eclectic, confused, and rather disappointing. He established six orders: "rich," or ornamented, and "simple" versions of the three main classical orders. Evidently, Patte had greater faith in his method than in the result. Empirical science progressed to the degree to which observations were accumulated and systematized. He believed that any system based on his method was assured of becoming truly objective, producing real satisfaction.

The last architect whose work I examine in this chapter is Nicolas Le Camus de Mezières. Between 1780 and 1782 he published three books, two concerning technical problems and the other dealing with harmonic proportion. In the introduction to his *Traité de la Force de Bois,* after mentioning several buildings that had suffered structural failures, Le Camus pointed to the existence of mathematical laws derived from the science of mechanics. These laws, in his opinion, should always be respected. In his book, he commented upon the results of many experiments made by Buffon on the strength of wooden beams. Although he did not provide analytical methods for structural design, his intention was technical: the systematization of experimental results with the purpose of designing wooden structures scientifically.

In apparent contrast to this attitude, Le Camus emphatically defended the value of harmonic proportion in *Le Génie de l'Architecture*. Architecture, in his opinion, should have "character," indicative not only of its type but also of its internal composition. Each room in a building is meant to have particular qualities, so that our desire for other rooms may be stimulated: "This agitation occupies the intellect and keeps it in suspense."[79] According to Le Camus, the objective of architecture is to move our souls and excite our sensations. And this could only be achieved through the use of harmonic proportion.

Le Camus was convinced that "there was only one beauty," which could be found in the purity and harmony of proportions. But he never provided a system of dimensions that could be applicable to practice, only some traditional advice and the suggestion to avoid irrational or excessively small proportions, which might be confusing. In a more radical way than his predecessors, Le Camus rejected the possibility of an *ars fabricandi* concerning the fundamental problem of proportions. The immutable *mathesis* was indispensable in architecture, but it could not be made synonymous with a set of rules. Harmony, wrote Le Camus, is only accessible to the genius: "It is a spark of Divinity whose smallest reflection carries the imprint of a dazzling source."[80]

Le Camus tried to provide general prescriptions for the design of buildings with true character, something he perceived as lacking in the work of his contemporaries. Because natural phenomena could produce sensations such as happiness, sadness, sublimity, and voluptuousness, he exorted architects to capture these effects in their forms. Meaning in architecture had to be attained through a careful study of Nature. Proportion was understood as the essence of beauty because number constituted the most explicit form of a natural harmony pregnant with poetry, the ultimate source of architectural expression. Proportion alone could "cast that spell that overwhelmed our souls."[81]

Le Camus was aware of the critical importance of his theory and defended it, not without anguish, from the menace of relativism. He wrote, "Architecture is truly harmonic. . . . Our principles about the analogy of architectural proportions with our sensations are derived from those of the majority of philosophers. . . ."[82] These principles constituted, in the words of Le Camus, "the metaphysics of architecture," upon which followed its progress. The ultimate meaning of architecture depended on the existence of these absolute, natural principles.

After such an emphatic declaration, it is not surprising to encounter a violent criticism of Perrault's theory. Indeed, Le Camus thought Perrault was mistaken in his belief that "immutable proportions should not exist, that taste alone should decide," that too many strict rules restricted and sterilized the genius of the architect.[83] Le Camus identified Perrault's theory with relativism and contested it by establishing a circular argument that was noncontradictory only in the context of eighteenth-century epistemology: It was imperative to establish "immutable points of departure," laws that might set limits to our imagination, which in itself was licentious and incapable of self-restraint. Le Camus was obviously referring to the fundamental philosophical principles of architecture, not to an invariable, merely prescriptive, theory.

Among the traditional works admired by Le Camus were Ouvrand's treatise on harmonic proportion and the commentary on the Book of the Prophet Ezekiel by the Jesuits Prado and Villalpando, who illustrated how the Corinthian order and classical proportions were derived from the Temple of Solomon in Jerusalem.[84] But he also praised the more recent work of another Jesuit, Père Castel, who had been fascinated by Newton's discovery of the mathematical laws of optics and had composed a treatise to prove the analogy between the harmony of color and music.[85] Castel built an organ, or *clavecin oculaire,* in which a special mechanism produced colors relative to the notes played. The instrument was admired by the composer Telemann and also by Le Camus, who saw in it a proof of his own theories. The colors appeared in harmonic succession, he wrote, charming the sight of a well-educated man with the same magic of the well-combined musical sounds that enchanted his hearing.[86]

Number in Natural Philosophy

The major architects and theoreticians of the French Age of Reason ultimately accepted the mythical belief in proportion as the source of beauty and values. Looking back, what can we say about this reactionary attitude that always rejected the protopositivism of Perrault and adopted François Blondel's traditional position? First, this preference cannot be interpreted as a mere revival or survival of Renaissance theories. Modern historians of architecture have felt the need either to ignore or to isolate this attitude, perceived as curious and extraneous to the dominant characteristics of the period, which was marked by an ever increasing rationalism and interest in technology.

But Neoclassical architecture is not merely a dogmatic and rationalist precedent of contemporary practice. The theory behind this architecture was still prepared to accept an implicit but fundamental mythical dimension, one that allowed reason to elucidate the basic metaphysical questions of architecture while still avoiding contradictions.[87] The increasing rationalization evident in architectural intentions during the second half of the century was only the most conspicuous sign of architecture's adoption of the methods and principles of natural philosophy. The full meaning and implications of this assimilation have never been seriously considered by historians of art, architecture, and engineering since they assumed that their respective disciplines evolved as autonomous entities. Architects, engineers, and philosophers of the Enlightenment explicitly identified the principles of architecture with those of science, presuming a fundamental analogy in the methods and sources that led all human disciplines to the attainment of truth.

The science of the Enlightenment was the natural philosophy of Newton. After 1735, when his methods and premises were generally accepted in Europe, Newton appeared as a hero of superhuman dimensions, having solved once and for all the enigma of the universe. Many popular versions of his philosophy appeared in different languages, and he became a venerated figure among philosophers, scientists, poets, engineers, architects, and even priests. His scheme of the universe became a model for all disciplines, including aesthetics and architectural theory.

It might be said that during the Enlightenment, the science of Newton took the place of philosophy. Rejecting as fictitious the great deductive metaphysical systems of the seventeenth century, Newton declared that science should not make hypotheses or substitute reality as it presents itself to our senses with false or fantastic representations. Natural philosophy, for Newton, constituted a compendium of laws that attempted to explain the behavior of the physical world in mathematical terms and was deduced from phenomena through induction and experimentation. His principles were presented as a discovery of mathematical relations in the observed phenomena. And it was precisely his great success in establishing a connection between mathematical theory and the experience of everyday life that allowed his natural philosophy to be perceived as the final refutation of traditional metaphysics.[88]

Newton always tried to explain with the smallest number of principles the diversity of phenomena in the real world, reducing them whenever possible to one universal law. His model of the cosmos became the only acceptable system for eighteenth-century epistemology: a systematization of knowledge through the observation of nature, rejecting a priori hypotheses while searching for and finding general principles and often a universal *mathesis*.

Newton seemed quite capable of distinguishing between final causes and the mathematical laws derived from quantitative observation and understood as simple formulations of the empirical world. Alluding to the essence of gravity, he declared his interest in establishing the phenomenon's mathematical law, not in discussing "the cause of its properties." Consciously eschewing metaphysical or transcendental questions, he often disclosed the autonomous formal character of scientific discourse.[89] Consequently, he rejected all symbolic connotations of mathematics and seemed prepared to use it as an instrument for resolving problems in physics. His discovery of infinitesimal calculus derived from this specific practical consideration, which contrasts markedly with the symbolic and universal implications that Leibniz, its almost simultaneous codiscoverer, saw in it. For Newton, the origin of geometry was not intellectual but practical; geometry was only a part of universal mechanics, whose objective was "to postulate and demonstrate with precision the art of measurement."[90]

Around 1750 many scientists and philosophers could criticize the mathematical exterior, or geometrical form of thought, that purportedly had guaranteed absolute truth in the philosophy of the previous century. D'Alembert, for example, disapproved of the work of Euler, Spinoza, and Wolff precisely because their ideas were structured *more geometrico*. Mathematics apparently could be conceived as a mere formal system of relations, with no inherent meaning.

Having proved experimentally the imaginative intuitions of Galileo, Newtonian physics presented a definitive formulation of modern epistemology, becoming a model for all future knowledge. Newton seemed able to recognize truth from illusion, objective science from subjective speculative philosophy. He made available a relation between theory and practice in which the former aspired to be no more than a mere description of the technical means of the latter and not a discussion about its meaning. This opened the way for positivism, or the possibility of acquiring the truth about things without a concomitant theory concerning their natures. Or, more simply, the Newtonian schema encouraged the belief that it was possible to know a part (meaningfully) without knowing the whole.[91]

Although correct from the point of view of its consequences, this interpretation of Newton's thought is totally inadequate in its own terms. The great British scientist devoted much of his life to alchemy and theology, concerning himself with the Rosicrucian texts and the archetypal Temple of Jerusalem.[92] His theological writings were criticized even during the eighteenth century, but the fundamental metaphysical presuppositions of his natural philosophy were implicitly and thoroughly assimilated into all the scientific endeavors of the Enlightenment.

Particularly after Einstein, it became abundantly clear that Newton's "empirical science" worked precisely because it started from hypothetical and absolute premises. The existence of independent, geometrical, and absolute space and time was, indeed, an a priori postulate, indispensable for the success of his physics. In Newton's most important work, *The Mathematical Principles of Natural Philosophy*, observed phenomena from the world of everyday life were explained as relations of geometrical bodies in an abstract, empty, and truly infinite space. Newton was aware that the concept of absolute space was obviously not the space of human experience, and so there seems to be an unavoidable contradiction emerging from the simultaneous adoption of an empirical method and the hypothesis of absolute time and space. In Newton's philosophy, however, absolute time and space were not merely formal mathematical entities implicit in the experimental method. They were unquestionable premises precisely because he perceived them as transcendental manifestations, as symbols of the omnipresence and eternity of almighty God. "God," wrote Newton, "endures forever and is everywhere present; and by existing always and everywhere, He constitutes duration and space. . . . In Him are all things contained and moved; yet neither affects the other."[93] This "primary existing being," whose "emanative effect" is space-time, was consequently responsible for the order, regularity, and harmony of the structure of things.[94] Newton believed His intervention was required constantly, but most particularly, of course, when man was confronted by irregular phenomena that could not be easily explained within the framework of his universal law.

During the eighteenth century, God was still required in the universe of theoretical discourse, and Newton's natural philosophy simply took the place of the traditional metaphysical systems as a foundation of religion. In fact, Newton believed that science would necessarily lead to a true knowledge of the "first cause." This belief became commonplace among writers, scientists, and artists; it was interpreted literally in Craig's *Mathematical Principles of Christian Theology* and in Derham's *Astrotheology*, and in a more sophisticated and rational fashion by Voltaire and Buffon. The religious principles of natural philosophy were also practically identical to those of Freemasonry, the most popular "religion" of the Enlightenment after 1725,[95] and scholars have pointed to the great interest and often clear affiliation of eighteenth-century architects with this society.[96]

The law of universal gravitation summarized the quantitative essence of the cosmos. One principle explained the motions of the heavenly bodies and those of any object in the sublunar world. The order of Newton's universe depended upon the existence of gravity, yet there existed only a relatively small amount of matter in motion within an infinite and homogeneous space. How then could gravity account scientifically for the essential order? Attraction had been a common enough concept in the astrobiological cosmos of antiquity and the Middle Ages, which explained it as a projection of human affection. Animism and inexplicable forces, however, had been rejected by seventeenth-century scientists, who attempted to explain motion mechanically, that is, as the result of immediate and direct physical actions. Newton was unable to explain the nature of gravitational force, but he appeared willing to accept action at a distance through a vacuum. He conceived of gravity as substance, not merely as a mathematical formulation. Gravity could only occur in the absolute space that is God; its universal mathematical law was postulated as a consummate symbol of divine existence.

Deep within Newton's empiricism was a Platonic cosmology. He believed that after having created the great masses composing the universe, God put them in motion within Himself. The creation of matter from pure space is a notion that appeared in Plato's *Timaeus*. This is also Newton's ultimate source for his understanding of the corpuscular structure of matter and the properties of its particles, a conception he shared with other Neoplatonic philosophers, in particular, Henry More. Newton allotted occult properties to particles in his *Opticks* in order to justify the ultimately successful hypothesis of the structural similarity between electricity and gravity. Inspired by Newtonian empiricism, Condillac wrote that physical science consisted in "explaining facts by means of facts." Paradoxically, nothing could be further from this than Newton's own natural philosophy.

Newton's philosophy was based on the proposition that number and geometry were the essence of external reality, their only true form. But having rejected seventeenth-century metaphysical systems, and recognizing the limitations of formal thinking, he opted for inductive methods and asserted that knowledge should always derive from the observation of reality. This created the belief in the possibility of demonstrating the mathematical and geometrical essence of reality through the observation of nature. The metaphysical preoccupations implicit in Newton's traditional cosmology retained, often surreptitiously, but always forcefully, their essential role in the realm of theoretical discourse. The order manifested by the mathematical regularity evident in nature became an immediate symbol of divine presence in the world of man. Physical reality, although excluding all supernatural phenomena, was still capable of revealing the ultimate meaning of human existence.

Newtonian physics was evidently successful in the experimental field. This was instrumental in the arts and sciences of the Enlightenment adopting both its methods and its implicit beliefs. During the eighteenth century, most thinkers rejected the traditional link between human and divine reason, generally renouncing all hypotheses and the authority of ancient texts and envisioning truth as the goal of experience. In this sense, enlightened reason was more humble than Baroque philosophy, believing that truth belonged in the world and was part of empirical reality. The task of theory was to disclose the rationality evident in the natural order. This meant that such operations were never merely motivated by a technological interest, but were grounded in metaphysical necessity. In short, the ancient myth of preestablished harmony was now revealed to man through experimentation and technical action.

The use of inductive methods began to be seen in all disciplines as a guarantee of absolute certainty and meaning. Newton had shown that such methods could reveal the mathematical wisdom of Creation. This was a not gratuitous hypothesis, but a fact accessible to immediate perception. Man could now presuppose the integral rationality of reality and assume its validity in any branch of theory. The new empirical method and the systematization of knowledge became an indispensable stage in the process by which theory was transformed into an effective instrument of technological domination in the nineteenth century. The same empiricism, however, gave renewed priority to practice (rather than theory) and permitted the symbolic perception of nature. All those immutable principles that reason "discovered" through the observation of nature were seen as a manifestation of divine will. The reason of the Enlightenment could come to terms with radical problems of meaning only because it had deep roots in the mythical realm.

The method of natural philosophy put a new emphasis on the embodied perception of the physical world. Knowledge about life became inseparable from sentiment, differentiated but consciously integrated in artistic manifestations. The perception of the universe was truly symbolic, capable of apprehending meaning behind the presence of reality, and thus avoiding the menace of subjectivism. Nature was the place where all human values were to be found, a transcendental reality full of life and movement, where God, man, and things were subject to mathematical harmony. This fundamental belief prevented theory from becoming an instrument of technological domination; man always felt the need to reconcile himself with Nature.

During the eighteenth century, man thought he was capable of discerning the hand of God in His work through the discovery of mathematical and geometrical laws that betrayed His presence. God no longer inhabited a supernatural sphere from which He communicated with the human mind; the Creator of the Enlightenment was a force that endorsed the perpetual miracle of everyday life. Corresponding to this transformation of divinity, geometry and mathematics, which had lost their symbolic power with the end of traditional metaphysics after Leibniz, recovered it from a Divine Nature. Paradoxically, this recovery was precipitated by the growing interest in technical problems that revealed the presence of a symbolic mathematical harmony through quantitative experimentation.

Architecture had traditionally depended upon geometry and number to vouchsafe its role as an immediate form of reconciliation between man and the world, between microcosm and macrocosm. During the second half of the eighteenth century, architectural theory, sharing the basic premises, intentions, and ideals of Newtonian philosophy, adopted an implicit metaphysical dimension. The results appeared as a passionate defense of traditional positions, strengthened by a consciousness of the power of reason to control practical operations. Deriving its fundamental principles from Nature, architectural theory was capable of maintaining its customary role as a metaphysical justification of practice. Thus while respectfully modifying Nature, building *praxis* remained *poesis*, the character of which was determined primarily by its reconciliatory aims.

During the eighteenth century, rationality in architectural theory was capable of disclosing differences of taste and opinion, questioning the absolute value of the classical orders, the authority of ancient and Renaissance texts, and even the specific myths that explained the genesis of forms. In the end, however, architects and theoreticians did not accept subjectivism and relativism. In the last decades of the century, theory became a set of *grands* *principes,* often impossible to describe, but postulated emphatically as a necessary source of architectural meaning. Apparently subjective notions like taste, once it was established that they originated in Nature and experience, could be invoked as absolutely objective reasons in favor of theoretical arguments.

Perhaps the most explicit work on "Newtonian aesthetics" was Abbé Batteux's *Les Beaux Arts Réduits à un même Principe* (1746). He believed that taste was the foremost principle of the fine arts and that these disciplines were therefore never subject to chance. Batteux stated that "taste is for the arts what intelligence is for the sciences."[97] He thought that the intellect had been created in order to know truth and to love goodness and that we should simply let our hearts choose freely. Each aspect of human consciousness had, in his opinion, a legitimate objective in nature. Even symmetry and proportion were determined by the laws of taste.

Once the transcendental dimension of mathematical reason is established, it becomes evident that there were no contradictions between the technological and the traditional interests of eighteenth-century architecture. In fact, the true meaning of Neoclassical architecture can only be understood after accepting the radical coherence of its technical and aesthetic dimensions. In a similar way, taste reconciled the lightness of Gothic with the purity and grace of classical architecture. It is therefore futile to attempt an elucidation of Neoclassical architecture as a juxtaposition of formal styles, systems, or the specialized interests of architects and engineers.[98]

After 1750 numerical proportions recovered their traditional role in architectural theory. An ever increasing empiricism brought architecture constantly closer to nature. Architects strived to imitate the *belle Nature,* finding it increasingly more simple. This process, which I shall try to clarify from diverse perspectives in the following chapters, already shows the great impact that the Galilean revolution had upon architectural intentions during the seventeenth century and the basically traditional framework of eighteenth-century theory and practice. It should already be clear that modern architecture did not appear around 1750 and that it was not simply generated by the Industrial Revolution. The process of transformation of theory into an instrument of technological domination started with modern science itself. Nevertheless, after adopting the humility of natural philosophy, the architecture of the Age of Reason became motivated primarily by a symbolic intention.

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II

GEOMETRY AND ARCHITECTURAL MEANING IN THE SEVENTEENTH AND EIGHTEENTH CENTURIES