Going Inside Architecture: A Tentative Synopsis for a History of the Interior

by ELIAS CORNELL

INTRODUCTION

A recommendable approach to architecture is to take the whole of each object as a point of departure and to look for its essential opposites: interior and exterior. Three elementary questions, then, will present themselves: How have the builders mastered the interior? How have they mastered the exterior? How have they mastered the relationship between interior and exterior? The interior is, as a rule, a building's principal aspect, its very heart, the place where its intended activity, its events, use, function are fulfilled — determining the fundamental conditions for its users and visitors, their experience and state of mind. The exterior is, as a rule, subordinate, designed for introduction, preparation, presentation.

Such a conception, however, must not prevent us from noting other relationships of interior to exterior. Especially in religious buildings the conditions can be different. Interiors can stand without exteriors, exteriors without interiors; and the relationship of the two opposites can be reversed. Where the main activity takes place outside, before the façade, the exterior will be treated as primary and the interior, the inside, will be subordinate.

To describe, characterize and interpret a building we try to follow, in principle, our experience and its successive development, its course during our visit or our dwelling there — taking the building into our possession. For this in most cases experiencing the exterior will, in spite of its subordinate position, be the start, preparatory — arousing expectancy outside as to the course of the experience towards its fulfilment within.

As to theory, I conceive architecture as the artistic organization of practical reality, 'practical' covering construction as well as use. Architecture can never be purely artistic, nor purely practical. As to terminology, only two words — one word-pair — need to be explained precisely, since they are not in common use: tectonic versus stereotomic. 'Tectonic' is not so rare: its use is meant to facilitate the description of elements whose aspect is primarily constructive — really or symbolically — as parts of the structure: columns, entablatures, lintels, skeletons, arches. 'Tectonic' can often be used to underline the feeling of expectancy before exteriors, façades. 'Stereotomic' is

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not so common: its use is meant to facilitate the description of something soaring, suspended, floating, hollowed out, distanceless, with little constructive articulation. Cupolas, domes, the insides of big tents, flat or concave ceilings are stereotomic. They are often painted to imitate the sky, something weightless, lifted up, elevating. In interiors the word may point the feeling of fulfilment and stillness. Obviously exteriors also can have stereotomic elements like niches or plain domes. And interiors often have tectonic elements such as columns or pillars in their lower zones.

Now, with a mind open to fantasy, let us summon feeling, senses and intelligence to take a few imaginary walks through some lesser-known shelters built by their users and some well-known architectonic monuments of different type and age in Europe and elsewhere. My choice of buildings comes more by intuition than from any systematic ambition towards completeness. We shall pay more attention to the individuality of the buildings than to identifying them as links in some alleged chains of historic development. And we must avoid those erroneous propositions involving false analogies with natural science which are put forward by writers who disregard the simple fact that human building is man-made. Calling buildings organic, for example, may seem a harmless metaphor; nevertheless it has led astray the thought even of eminent scholars and craftsmen.

ORIGINS: THE SELF-BUILDERS

The Invention of Architecture

Hundreds of centuries ago our ancestors developed themselves into humans by their work. And they made many inventions, including language, music and singing, how to make tools and fire, cooking, gods to believe in. They also taught themselves to make shelters. These were primitive in its fundamental sense — not in that of an obsolete jargon that thinks in terms like 'wild men', 'savages' and so on. On the contrary, their shelters denote the most decisive invention in the history of architecture: they were its very origin.

The inventors were wandering gatherers, as we call them, picking seeds and other plant food, catching small game on earth, in trees, in air and waters. On their resting places, where they stayed for a few nights, they built shelters, sloping screens, curved or flat, over berths to sit and to sleep on. Their fire they made in front of the screens that stood open to field, bush, wood, waters, valley.

The Invention of the Interior

Some gathering peoples, at times still unknown to us, found out how to ameliorate their ways of living. Often independent of one another, as can be the case with inventors, they came to specialize in either plant food or hunting, turning into herbivorous harvesters or carnivorous hunters. Each, though in different ways, could stabilize their lives within their habitat: the harvesters became tied to the earth and could settle for whole seasons, attaching their houses to the ground; the hunters had to move according to the migrations of their prey: they had to carry their huts and tents with them, since they could not find suitable building material everywhere. They

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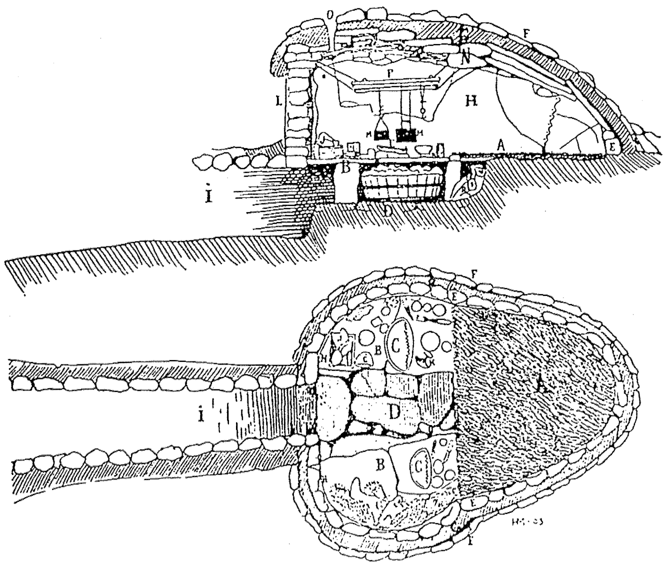

Fig. 1. *Thule. Inuit stone hut with enclosed tent: section and plan, 1903*

loosened their huts from the ground, made them lighter, able to be taken to pieces, bundled or folded, re-erecting them at the next camp. Thus they managed to stabilize a wandering life that was stretched over vast areas through seasons and different climates.

With both harvesters and hunters one development surpasses all others: better to protect themselves, their food, their tools and their fire, they closed their shelters all around them. In so doing they made the greatest advance in building since the beginning with screens: they invented the interior. Its deepest significance for them as humans was that they thus made themselves ready to leave behind a life of mere survival and could set about an incipient flourishing life. In the literature they are known as collectors.

The move from a life as gatherers to one as collectors did not mean a sudden rupture in building traditions. A unique known case of the transition reveals a certain continuity. The northern Paiute or Paviotso Indians of south-east California wandered as gatherers in summertime, erecting semicircular screens at their resting places; towards winter they settled in Owen's Valley, at the foot of the Sierra Nevada, looking forward to the big harvests that they could reap in the spring from the wild grass that they made grow abundantly by forcing the rivulets to inundate large areas of land. In the expectation of harvests they closed in their shelters, in principle by letting two curved open screens meet to form a round hut. Collectors who used straight screens combined these into rectangular huts; collectors like the whale-hunters on the north-east coast of America could develop their rectangular huts by raising roofs on to vertical walls, so creating demountable houses which they could transport in boats when shifting camp along the coast.

The interiors that the collectors created, and can still use, have similar features in many countries. The fire on the open hearth gave light in dark hours: its smoke,

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sooting walls and ceiling, escaped through the reed or other wall material or, more often, through a hole at the top that shed a mild and clear light in daytime. Vision within the room was limited and defined by the natural material of the wall skeleton and its covering.

This atmosphere, with the hearth as it centre, remained the lot of innumerable peoples. The tradition continued when many hunters made themselves nomads and harvesters became cultivators. In principle it continued when populations settled as farmers, with the double livelihood of both harvesting seeds and breeding animals. For millennia following this 'neolithic revolution' their fire burnt on the hearth at the centre of their increasingly stable houses of stone or wood. Not until the fifteenth century did the regular use of chimneys allow it to become normal for the fire in European houses to be within a stove or fireplace in a corner or on a wall, so giving all the floor to the inhabitants; and only in the industrializing countries from the late eighteenth century onwards do the hearth traditions end as more and more the fire comes to be enclosed in iron stoves, and subsequently through the use of gas and later electricity.

THE GROWTH OF THE MONUMENTAL INTERIOR IN EUROPE

The Mycenean Age in Greece

Houses for the living were the roots of ancient monumental architecture in Europe. The oldest type of stone house was circular, specimens of more recent times still standing abandoned in some Mediterranean provinces. Thousands of years B.C. kings and noblemen refined and magnified this building type into grotto-like grave-chambers. These were made of boulders fitted upwards into dry domes held together by compression. Intuitively the traditional builders felt what we call the pressure line. It was by adapting this technique in the second millennium B.C. or earlier that the royal architects with extraordinary craftsmanship and poetic fantasy constructed the magnificent chambers at Mycenae and elsewhere. The type is the tholos; that at Mycenae the Romans called the Treasury of Atreus; the Greeks today say Agamemnon's tomb (Figs 2 and 3). Its volume is at least ten times that of older graves. The architects devised a system of corbelling for the vaulting, piling fine-cut blocks of silicon conglomerate in cantilevered rings from floor to apex.

From the outset we know that the monument is symbolic in every aspect. It was built on the ground to represent a grotto-grave: earth was cast upon it to press down the construction but also to give the impression of something secret, hidden underground. The battered side-walls framing the walk to the entrance act as buttresses to the vaulting at the doorway, the point where the stone rings are not complete; but the walls were also meant to symbolize a way into a mythological subterranean world.

After the interments the entrance, with its half-columns, was closed, stressing the secret character of the tomb. The triangular window over the heavy lintel was closed by a decorative flat stone, which has now disappeared so that light, originally forbidden, can enter the chamber. Although respect for the original secrecy has been dissipated for millennia we still feel something like late-coming intruders when we walk in between the great blocks that carry the heavy lintels. We stand under the great

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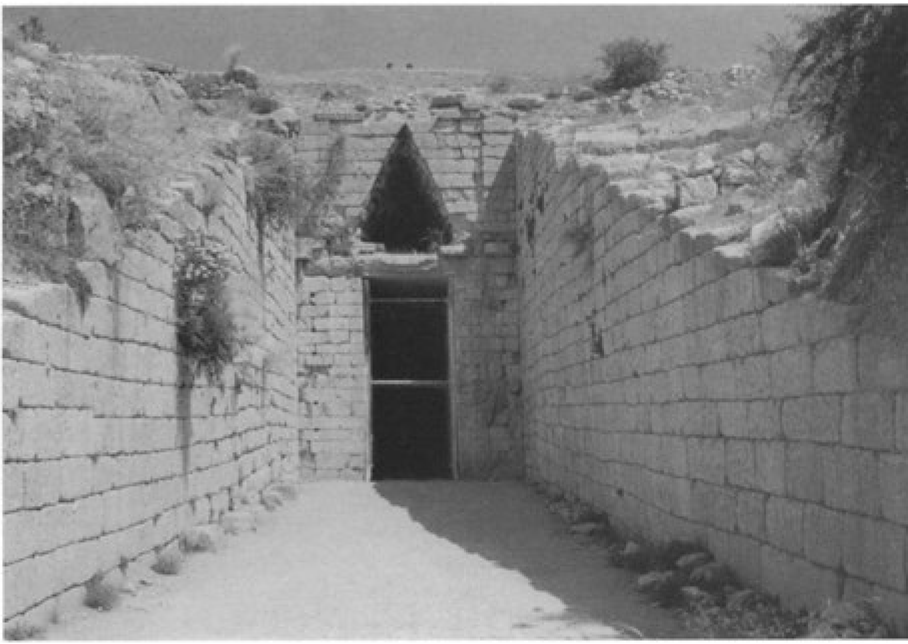

Fig. 2. *Mycenae. Agamemnon's tomb (fifteenth century B.C.): entrance*

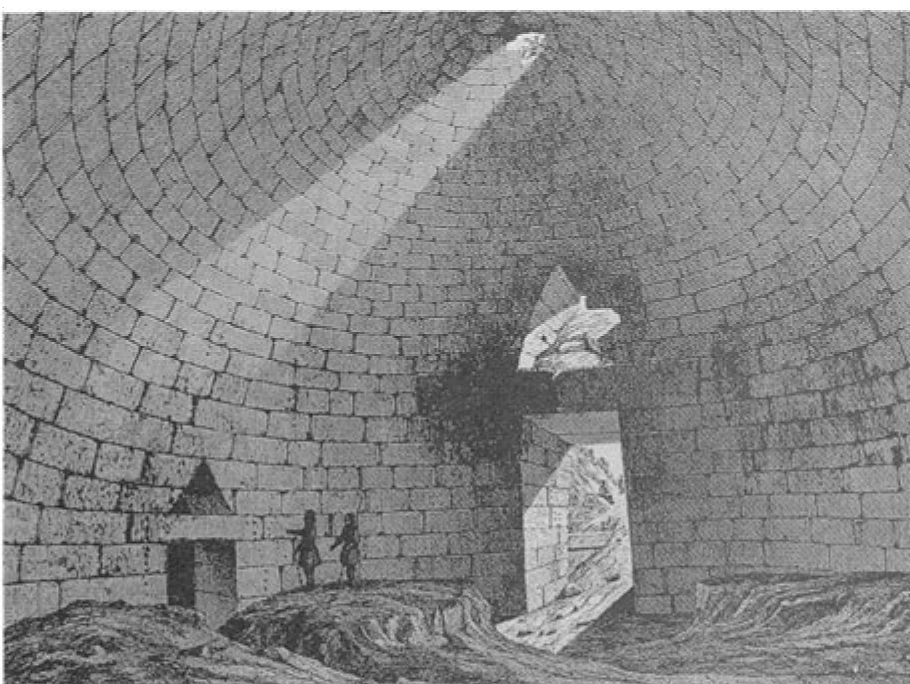

Fig. 3. *Mycenae. Agamemnon's tomb: interior (woodcut of 1852)*

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vault and our eyes adapt slowly to the dim light from the ruined window and the deep entrance. Since feelings often come before close reflexion and are specially important in the understanding of art, we try to consider our first impression: what we perceive is a peculiar tension that remains after our eyes discern the vaulting and its blocks more clearly. Does the tension come from the contradiction between the heaviness of the stone blocks and the lightness of the vault they form? We try to conceive the meaning of the chamber: it is a grave and it is built up as a symbolic, not a natural, grotto, even though it has the form of one underground. But where does the impression of something like an intended contradiction come from? The meaning, the symbolism, must be double: the impression is of heaviness so long as we keep our observation to the stone blocks; but when we visualize the vault as a whole we perceive a distanceless lightness quite opposite to the weightiness of the stones. We look at the vault with screwed-up eyes to allow the vision to dominate and discover that it depicts the sky — that is, the opposite of the underground. The remnants of bronze ornaments in the ceiling, then, could have been stars: it must be the sky by night.

Let us assume that the chamber's architecture is a mythic poem of the royal person's fate after leaving life on earth to enter eternity. Then the underground grotto-chamber is the symbol of her or his passing visit to Hades. And the heavenly character of the vault is the symbol of her eternal abode in that Olympus whither royal persons went as descendants from the gods to share eternal existence with their divine ancestors.

The Age of the Greek Republics

The scope of architects in archaic and classical Greece differed in many ways from that of the Mycenaeans. While the latter had to make for their god-descended royalty a Heaven — something they did not have on earth — the later Greeks had to give their gods something *they* did not have on earth, namely a house, an abode for their symbolic visits to humanity to receive sacrifice and be worshipped.

The sacrificial ceremony, the important activity at a Greek temple, was performed outside, in front of the entrance end of the building, not inside. Thus the scene of activity was that part of the temenos under the open sky, the sacred precinct that the temple faced, the whole religious ground being conceived as an interior. The holy magnificence of the goddess or god was emphasized and symbolized by the extraordinarily elaborate exterior as a background for the officiant before the crowd. As architecture, then, the temple could not have an elaborate interior, only an inside, since the architect could not fathom the claims of a secret divine abode. The inside served only for storing the effigy and for the priest's preparatory ceremonial (Figs 4 and 5).

To get near to an understanding of Greek temple architecture we need to widen our conception of how different ages can have differing ideas about the relation between interior and exterior, those inherent opposites in most architectural works. Our conventions, going back at least as far as Roman times, tell us that the interior is the principal aspect of a building, since it is the place where our experience is fulfilled through the fulfilment of an intended activity; the exterior is then an introduction, the secondary side within the whole. These conventions, however, run quite contrary to

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Fig. 4. *Paestum. Temple of Hera (sixth century* B.C.*)*

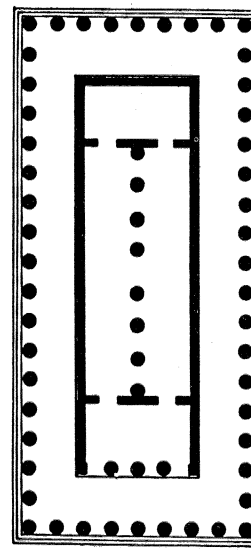

Fig. 5. *Paestum. Temple of Hera: plan*

those of the creators of archaic and classical Greek temples, of which they are essentially the reverse. Since the activity for which they were created, the ceremony of sacrifice, was performed outside, in front of the temple, the exterior was the important aspect, the inside was secondary. So the archaic temples of Paestum tell us of the respect the gods or goddesses were supposed to ask for: the exteriors are severe, their character forbidding; if they inspire expectancy we must allow the feeling to remain an abiding one, for there is no invitation to enter.

Iktinos and Kallikrates, the architects of Athena Parthenos' temple on the Akropolis at Athens, introduced new conditions for the worshippers (Figs 6 and 7). They harmonized the exterior, making it less absolute, neutral as to the question of expectancy. This was the way by which they enabled the exterior to take up a correspondence with the interior; for the Parthenon enclosed one of the first Greek temple interiors to be entered by the laity. Phidias' Athena stood at the end of the broadened cella, which was created as a sanctuary, surrounded on three sides by two-storeyed colonnades appropriately designed to accentuate the magnificence of the effigy. Humans had entered the temple as worshippers, transforming its inside from mere inner space into an architectonic interior.

The Development of Integration with the Romans

At the beginning of the second century A.D. the Pantheon built in the age of Augustus, the Temple of all the Gods, was destroyed by fire. This catastrophe was countered by something creative in A.D. 120, when the architects of the emperor Hadrian began the Pantheon that we can visit today. The masters accumulated a mass of architectural knowledge and material in the imperial capital to raise a totally new building on the

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Fig. 6. *Athens. Parthenon (447–432 B.C.)*

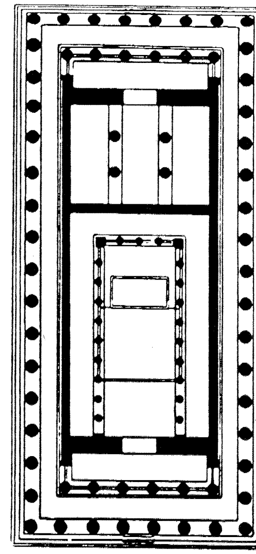

Fig. 7. *Athens. Parthenon: plan*

site of the old. In so doing they made a great contribution to the development of architecture.

The new Pantheon had an atrium before its entrance, where the Piazza della Rotonda now lies open. There visitors and worshippers arriving from the irregular streets of the city could assemble expectantly before the lofty entrance portico, with its eight plain columns of Egyptian granite supporting a pediment. Above it soared the high dome of the Rotunda. Even at some distance glimpses of its gold-like bronze covering shining over the city had been caught as people approached.

The columns of the portico are high but relatively thin, and they stand widely apart, to leave open the view into the shaded ante-room within the building. The whole façade of the portico stands as a tectonic introduction to the Pantheon, inspiring expectation in the visitor. Thus the colonnade has a different meaning at the Pantheon from those of temples whose exterior and interior were of two contrasting types of architecture and the colonnades were more forbidding than inviting. In the Pantheon exterior and interior are combined into a single whole, setting the pattern for all following ages, creating expectancy answered inside by the fulfilment of the experience.

We gain the clearest conception, the richest experience, of the Pantheon on a bright summer day at about noon. The sun stands blindingly over the dome. When we walk into the hall it seems, to start with, almost dark: the heavy door in the portal swings open, and we proceed into the temple, meeting the immense interior and the brilliant sunshine from the circular hole at the top of the dome. Our successive experience is transformed — expectancy into fulfilment. We walk out on to the floor with its pavement of alternating square and round flags in different colours and feel in our feet its slight rising up towards the centre as if to meet the voluminousness of the

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Fig. 8. *Rome. Pantheon (c. 120: painting by G. P. Pannini, c. 1734)*

interior. The interior engages our whole person with an awe-inspiring, overwhelming experience: we stand and move within a great image of our world, richly endowed with architectural and cosmographical symbols that call out to be deciphered. What do they signify, these masses of concrete covered with architectural accents in stone and stucco? (For a more complete view of the Pantheon than its present state allows we can call up Pannini's magnificent painting of the interior, made in about 1734, Fig. 8.) If the whole interior is the world, what then are its four distinct parts, the zones that we discern? The floor is the face of the earth. The surrounding rotunda, with its rising columns and pilasters of stone and stucco, make it part of an urban public place for religious meetings and worship before the gods who once stood in their astrological orientation as statues round the circular wall. The columns and pilasters

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carry a low upper storey, an attic: its windows take their light from the temple interior; tiny flat pilasters in the wall symbolize the ease with which the dome above is supported, the heaven. The religious significance of the whole attic is transcendence, penetration, an intermediary between earth and heaven, the human yearning for a celestial life after death.

The celestial meaning of the dome is witnessed by Roman authors: its conspicuous stereotomy gives a sensation of uplift, enhanced by the perspective of its cassette rings as they diminish upwards. What purpose and significance has the round hole in the dome's crown? Its brilliant light has a wider meaning than that of just illuminating the interior in an even light; the light was also conceived as divine, sent by the higher forces of heaven and nature. Furthermore the hole was the entrance of Jupiter or Zeus in the form of rain and lightning.

Finally, what were the conditions of the gods and goddesses within the realm of the Pantheon, where they were placed against the rotunda wall? Man has conquered the interior still more clearly than in the Greek Parthenon. The Pantheon's images were statues — only symbolizing gods and goddesses — not effigies.

The Churches of late Antiquity

By the edicts of the emperor Constantine in the fourth century Christians were enabled to take control of the enormous building resources of the Roman Empire. The best evidence of this new prosperity is the Ravenna architects' clear and inventive differentiation of their sanctuaries in accordance with the several sacraments. We can sometimes observe them transforming building types from the Roman heritage in the most ingenious manner.

The baptistry at the cathedral of Ravenna was inaugurated in 458 (Figs 9 and 10). Its exterior is plain and bare, for baptism was at the time a semi-secret ceremony. We enter through a simple door and feel surprisingly stimulated — a sudden blaze of emotion. The interior is a strikingly elaborate visual and symbolic Christianized image of the world. It has six zones, three mundane and three celestial: Earth and Heaven meet along a thin line of division, at the base of the dome. The earthly zones are surrounded by sculptured architecture, the celestial part covered with mosaics illustrating Paradise and Heaven. The higher the zone the more fantastic: the unreachable architecture depicted in the mosaics is an architecture of the imagination.

We come near to understanding the whole by observing that the halves of Heaven and Earth mirror each other, so that the lowest and highest zones make one pair, the middle zones another and those meeting at the dividing line a third: the whole is built up on symbolic mirroring. The basin with its water is sunk into the earth to mark the symbolic death and rebirth of the neophyte, the person being baptized, through his descent into the underground water to die a symbolic death and return to the face of the earth to be symbolically reborn. Corresponding to the subterranean basin is the supercelestial picture in the cornice-framed mosaic at the crown of the dome, the uppermost zone representing a hole in Heaven with a symbolic meaning parallel to that of the hole in the Pantheon's dome, though at Ravenna nature's heaven is manifestly transformed into the Heaven of God and Christ: the mosaic is of the

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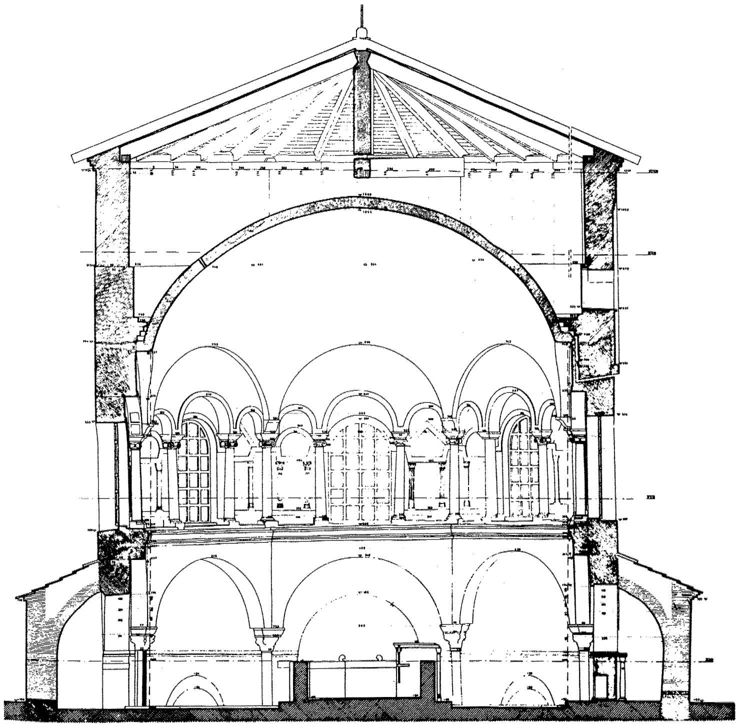

Fig. 9. *Ravenna. Cathedral Baptistry (458): section*

descent of the Holy Spirit as St John baptizes Christ, watched by the Jordan water-god. The pair of zones in the middle of the earthly and celestial halves are given to the assistants and witnesses of the actual baptism on the floor and correspondingly the Apostles as witnesses to the instigation of baptism circling the scene immediately below. What then of the pair of zones which meet at the dividing line? The uppermost zone of the mundane we could call the superterrestrial, with statues of preaching saints framed in tabernacles, while the lowest heavenly zone is sub-celestial — Paradise, with four altars reserved for the evangelists. Together the middle zones serve as links transcending the division of Earth from Heaven.

The tall centralized composition of the baptistry is specifically designed to reflect or express the vertically directed ceremonial movement of diving and returning. For divine service the architects had to organize their sanctuaries horizontally for movement towards the altar. The faithful assembled in an atrium, or simply in the open space, in front of the façade of the sanctuary, as at S. Apollinare in Classe, outside Ravenna. It is a basilica for singing, listening to sermons and sharing Holy Communion. The faithful enter a nave which is like a ceremonial street, directed towards the altar (Fig. 11). At the end of the service, after taking the Blessed Sacrament at the altar, they could look up into the apse and see in its mosaics a celestial image, once again in three zones: firstly Paradise, with St Apollinaris on a holy mead, flanked

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Fig. 10. *Ravenna. Cathedral Baptistry*

by sheep — the saint's herd of the faithful walking towards him or dotted about among trees and bushes. The crown of the vault is Heaven, with Moses and Elias, between whom and directly over the head of the saint is the image of a hole in Heaven surrounded by a decorative band and filled with golden stars: the deep concavity gives the worshippers an illusion of looking out into the nocturnal sky, the stars distanceless as Heaven itself, while far out in the centre is the Holy Cross with at its intersection the head of Christ himself.

The Ravenna architects showed their creative fantasy also by the spacial organization of chambers for the dead. The so-called Mausoleum of Galla Placidia is cruciform with the central square chamber rising into a tower designated as Heaven: if that view is accepted, it settles the argument as to whether or not the building was designed as a tomb or cemetery chapel. The celestial mosaic in the cupola of the baldacchino, with symbols of the evangelists at the four corners gives the vision of Heaven without intermediate elements like the regular framing bands round the holes depicted in representations of Paradise or the lower zones of Heaven. So the whole arrangement means that the deceased has reached Heaven, the highest, supracelestial Heaven.

Hagia Sophia

Hagia Sophia, the cathedral of Holy Wisdom, the greatest sanctuary surviving from the early centuries of Christendom, was built between 532 and 537 by the Greeks Isidoros from Miletos and Anthemios from Tralles at the command of those strange rulers, the emperor Justinian and empress Theodora, to demonstrate their elevated position as the deputies of God before all the people of the Empire. Civil war had destroyed the old Hagia Sophia, and the ground lay bare for erecting a completely new

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Fig. 11. *Ravenna. S. Apollinare in Classe (c. 600)*

building. The assembly gathered in an atrium in front of the immense church and proceeded through low-ceilinged ante-rooms into the great space of the interior (Fig. 12). The central dome floats as if weightlessly on pendentives that lean on arches in the side walls and others open to half-domes in the ceremonial direction. The present hemispherical dome replaced the original which was destroyed in an earthquake twenty years after it was built: to envisage the original form of the interior it is essential to know that the first dome did not swell up so high out of the interior space, its profile following that of an inverted catenary curve. Paradoxically this lower dome made even more impressive the whole interior, which seemed to rest on the ground like a continuous hemisphere of immense, never-before-beheld volume. At its crown was an imaginary blue hole, with stars and Cross, symbolizing transcendence and perhaps the prototype of the mosaic hole at S. Apollinare in Classe.

Hagia Sophia is one of the few architectural monuments of antiquity and the early Middle Ages that were described by their contemporaries. Most enlightening is Prokopios of Caesarea evoking his experience of the dome. He wrote that 'it does not seem to rest on firm masonry but to be suspended from Heaven in a golden rope', so picking up a symbolic metaphor of the connexion between Heaven and Earth that was already at least two millennia old, going back to the age of Homer. In the *Odyssey* Zeus boasts of his power to withstand the attempt of all the other gods and goddesses

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Fig. 12. *Istanbul. Hagia Sophia (532–37: lithograph by G. Fossati, 1852)*

to draw him down from Heaven to Earth by a golden chain. Prokopios also observes with rare psychological insight the discrepancy and epistemological correlation between his aesthetic experience and his technical knowledge of the building's construction. Hagia Sophia's dome seems to soar up in the air without firm support 'as if it were held up to the peril of those within the interior. But really it is held together with uncommon strength and security.'

Byzantine and Romanesque Building

St Mark's, Venice (Fig. 13), stands as a link between east and west in the early Middle Ages. Evidently the rulers of the mercantile republic had no ambition to compete

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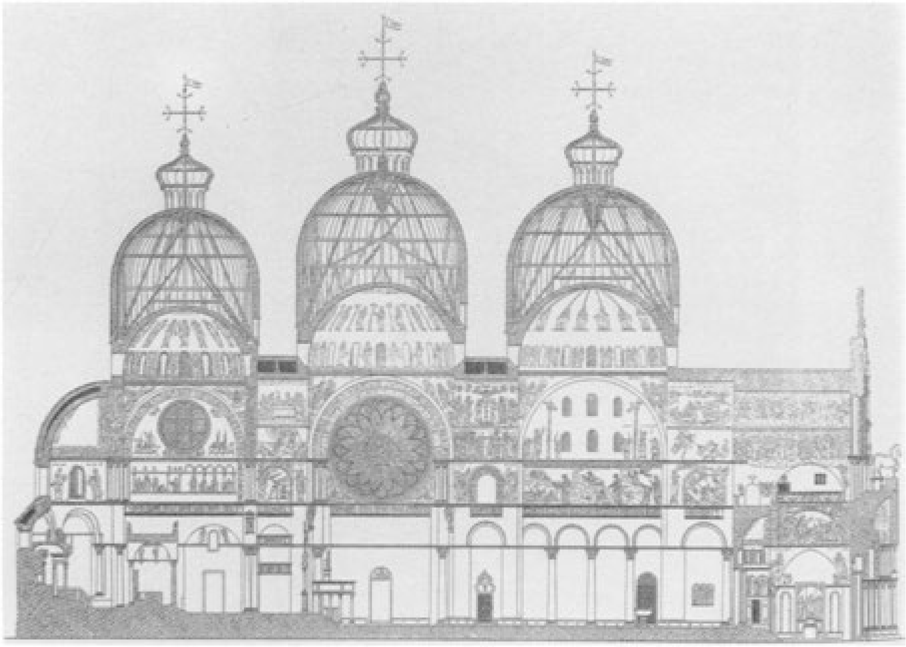

Fig. 13. *Venice. St Mark (c. 800–1200): section (F. Zanotto, 1858)*

with the Byzantine emperor and empress, for they chose not Hagia Sophia but another Constantinopolitan church as their prototype for creating the religious symbol of their power: the five-cupolaed church of the Twelve Apostles, long since destroyed. Some centuries after the building of St Mark's the rulers of Venice raised its importance in the townscape of the city by adding the lofty external copper domes that dominate the visitor's impression of the exterior. But on entering we see the church essentially as originally designed. Five hemispheres covered by gilded mosaics successively dominate the impression as we move through the interior. Their distanceless character makes us forget that their height is only two-thirds of the total height of the exterior domes.

In principle St Mark's stands at the limit of Byzantine influence on building in the west, though there are domed churches in French Aquitania and other provinces. In the east the Byzantine tradition lived on within the whole realm of the Orthodox Church and has continued even into the age of reinforced concrete. But from the ninth and tenth centuries onwards France, Britain, the German provinces, Italy, the Nordic countries and most other western provinces started their sanctuary architecture anew. Massive walls were the one feature that remained from the late Roman heritage of heavy concrete casting. But since all builders now used natural stone or sometimes brick, they turned inventive especially with vaulting. So they helped the rulers of the Church as well as royalty and noblemen to distinguish themselves and suppress their congregations before the Supreme Being.

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Fig. 14. *Gernrode. St Cyriakus (tenth century)*

Fig. 15. *S. Pere de Rodes. Abbey (c. 1000)*

The principal tendency throughout the Middle Ages is the striving for light and height to emphasize the symbolic communication with Heaven in preaching, prayer, music and song. From closed, flat-timber-roofed interiors like the tenth-century St Cyriacus in German Gernrode (Fig. 14) they went on to great vaulted spaces like the pilgrimage cathedral of Santiago da Compostela in north-western Spain. Steadily they invented new forms of construction and at the same time new articulation of the interiors with pilasters, vaulting and windows (Fig. 15). At greater churches they stressed the expectancy and yearning of the faithful by adding richly decorated west façades as half-independent parts of the fabric. Sculptured fantasy architecture was provided with statues and scenes from the Bible or other holy sources such as legends of the saints or even representations of craftsmen, philosophers and a miscellany of fabulous beasts. Until a new and decisive turn began in the late eleventh century with experiments as great and adventurous in England as in France.

The Emergence and Development of Gothic

The cathedral masters of Norman Durham (Fig. 16) devised a plan which would introduce a special method of raising their vaults and so let in more light high up and simultaneously give the whole interior a new character and atmosphere. Over each compartment they heightened the vault by introducing semicircular diagonal ribs, thus using less material for the severies and making the whole construction less heavy, even visually. It was their new vaulting principle that made it possible to lay out

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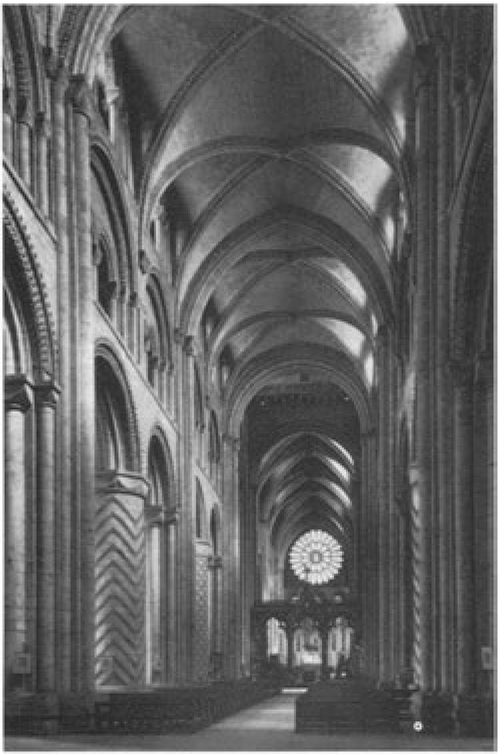

Fig. 16. *Durham. Cathedral: nave (1099–1133)*

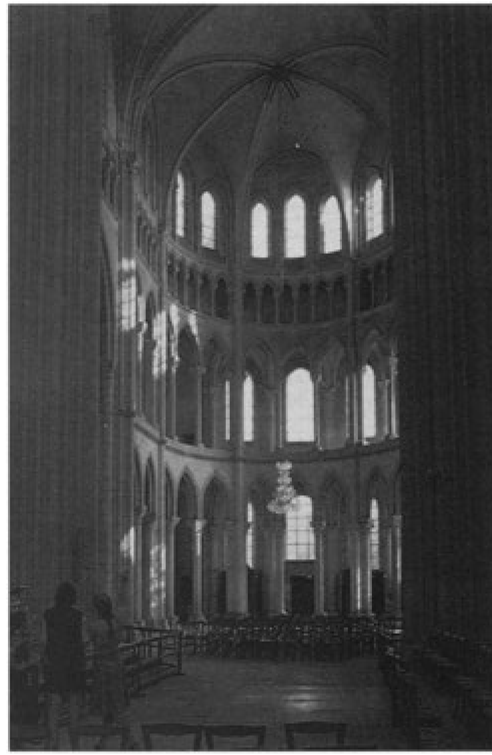

Fig. 17. *Soissons. Cathedral: south transept (1177–85)*

oblong rectangles for the compartments instead of squares as had hitherto been the rule. To give consistency to the whole vault the architects set pointed transverse arches between each pair of compartments so that they would reach a height equal to that of the diagonals. The rib-vaulting system presented the entire ceiling of the church with a new articulation: the tectonic ribs contrast with the plain stereotomic background, which was often painted blue with golden stars so that visitors got the impression — even the illusion — of looking through a net of ribs to a continuous sky, visually outside the interior. As compared with the depiction of a hole in earlier churches, this gave a greatly enlarged image of Heaven. The aim of combining a projecting net with a darker celestial background was to deepen and widen the worshippers' sense of transcendence into a new force by which the authorities of the Church could complete their suppression of heresy by peaceful mystic seduction.

In the age of travelling craftsmen the invention of the rib-system soon spread. The famous Abbot Suger of St Denis induced his architects to assemble and unite a large amount of the masonic knowledge of his age into a fusion of the definitive consequences of rib-construction. In the early twelfth-century choir of St Denis the parts are all members of a continuous skeleton that made walls unnecessary and let in

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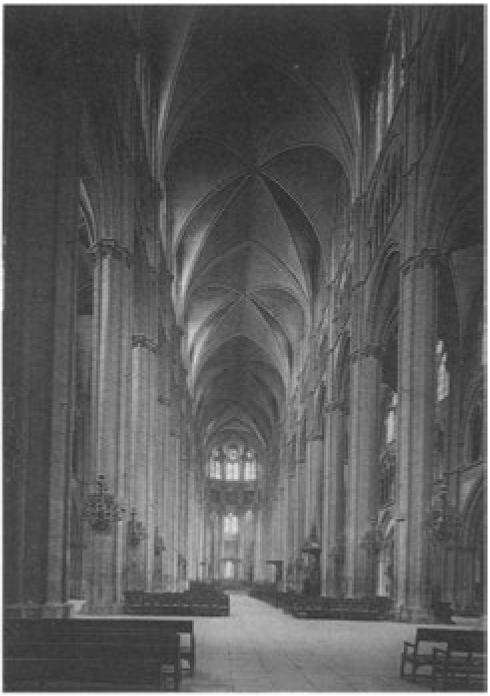

Fig. 18. *Bourges. Cathedral: nave (begun 1190)*

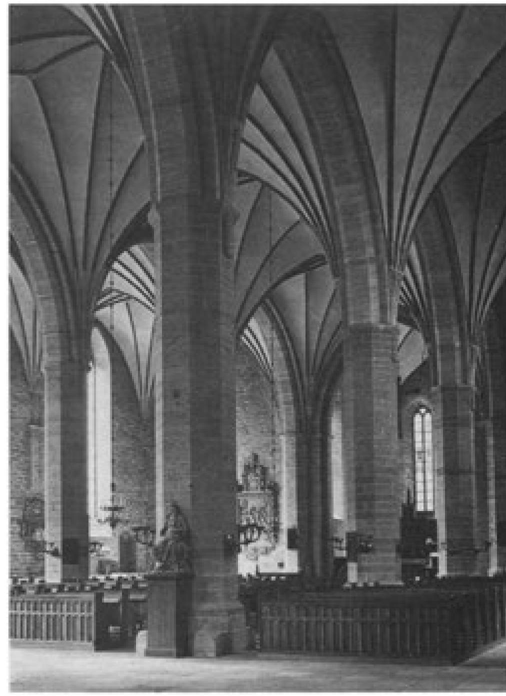

Fig. 19. *Vadstena. St Birgitta (begun* c. *1400)*

light through windows of a size never before seen (cf. Fig. 17). And Suger could also incorporate illustrative stained glass without abating the illumination of the interior.

The architects of Notre Dame, begun in 1163, and almost simultaneously of Noyon and Laon, brought the full Gothic rib-system into the building of cathedrals. Wider possibilities, however, were achieved by the masters of Bourges in about 1190 (Fig. 18). They abandoned the use of columns, which they replaced with rows of uniform pillars, along the nave and between the aisles, whose structural and articulating elements reach from the crown of the vault down to the pavement, thus letting the eye follow without interruption an uplifting movement from ground to top. And they opened up the space between nave and aisles to let the outer volumes surge in and up into the nave, whose own volume is larger than that of all the other parts of the church added together.

To understand the deeper sense of the architects' transformation, the revolution of their art, from Norman-Romanesque into Gothic, we should see their buildings as artistic-architectural interpretations of the profound changes that the theologians of their age brought to the conception of the Supreme Being in his manifestations as God and Christ. In the early twelfth-century mind there was still a double character in pictures of the Supreme Being. Christ on the crucifix is depicted as Lord-Father and Christ-Son in one, imagined as elevated above all suffering. By contrast theologians of the late twelfth century separated the two manifestations, the Lord-Father staying out

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of reach of humanity, not present in the church building, while the crucified Christ was humanized, remaining to suffer inside the church among his fellow humans. The Gothic interior is the artistic solution of this cleavage, illustrating by its strengthened transcendence the tension, the opposition, between the Lord-Father in an unreachable beyond and the Christ-Son, inside, meeting the congregation as their suffering and suppliant mediator between the Father and mankind.

The Gothic building system reigned in ever-varying forms in southern Europe until the fifteenth century, north of the Alps into the sixteenth and even later. Some of its deeper content may have fallen into oblivion among builders who developed their interiors in an essentially decorative direction, making architecture a matter more of free artistry: the fan vault in the cloisters of Gloucester Cathedral is typical. Here and there some forces diverged from this tendency: the Swedish St Bridget, Birgitta of Vadstena, had successors in the fifteenth century who followed her directions concerning her church; she was inspired by Italian Franciscan and Dominican simplicity, as well as by German builders of hall-churches with their equal-height nave and aisles. The unornate interior of her church of St Bridget at Vadstena (begun *c.* 1400, Fig. 19), with its unobstructed vistas between high rows of pillars and its lofty rib-vaults, conveys a strikingly simple solemnity which distinguishes the church from the many exuberantly equipped interiors of her age.

Renaissance and Baroque Times

In fifteenth-century Italy the richest merchant families had turned into powerful capitalists, ordering new surroundings for their lives, urban, private, ecclesiastical. One of the first masterpieces of the changed spirit is the Piazza Annunziata in Florence, designed by Filippo Brunelleschi and begun in 1419 just after he had started on the construction of the dome of Santa Maria del Fiore, the famous cathedral of the city. The dome (Fig. 20) is a masterpiece of construction that brought the Gothic system to its late, ultimate perfection, using double-shell masonry with reinforcing ribs which enabled larger domes to be built than previously without increasing their weight. Simply expressed, he omitted unnecessary inner material, knowing that stress acts at the surfaces. Now, with the Piazza, he appeared as the first master of Rinascimento architecture, his epoch being one of the few that of themselves invented the name of their own art (Fig. 21).

For the Piazza he chose two ways of leaving the Gothic tradition behind: one, for the form, archaistic, close to Italian Romanesque, the other, for the design, futuristic, using his own perspective methods to open new possibilities, to illustrate projects in advance on parchment or on paper as an easier alternative to model-building. By putting himself, so to say, on either side of his own time, it seems as if he wanted to give his architecture an objective character, a new autonomy as art. For the form he chose to refine late antiquity and Italian Romanesque columns and vaults, stressing above all their horizontal, reposeful character: hardly a single Gothic feature remains. It took the community of Florence two hundred years to complete the piazzetta, but the whole is essentially Brunelleschi's: his followers did not diverge much from his aims. He had invented the monumental piazza, with its insistent anti-aristocratic

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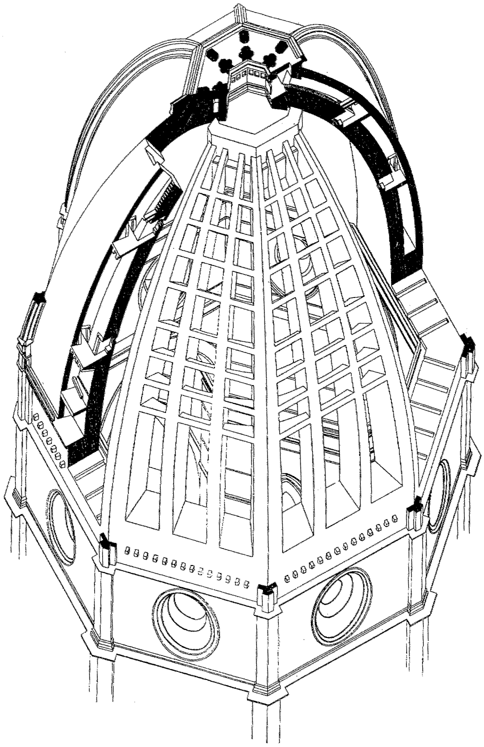

Fig. 20. *Florence. Cathedral: dome (Brunelleschi 1417: cut-away drawing by P. Sanpaolesi, 1930)*

Fig. 21. *Florence. Piazza SS. Annunziata (Brunelleschi, begun 1419)*

symmetry: in Florence it represented the ideal of the new bourgeois class and was its normative architectural expression.

Leon Battista Alberti codified the Renaissance ideal by making the monumentality of antiquity rule his entire work. His church of Sant' Andrea at Mantua, built fifty years after Brunelleschi's piazzetta, was designed to allow the Gonzaga family to show their magnificence before the public as well as before God. Coupled pilasters flanking arches into the side chapels render the interior strongly rhythmic: it can be called a virtual theatre whose form is dictated no longer by the transcendental symbolism of the Middle Ages but by the claims of a social hierarchy.

The free adaptation of antique Roman forms reaches its climax in St Peter's in Rome (Fig. 22). With unsurpassed structural and decorative skill Michelangelo and his many successors under fifteen popes set outside and inside in formal correspondence, sculpting as much as building: pillars, pilasters, entablatures, the entire formal arsenal combine into a gigantism — Michelangelo's *terribilità* — surpassing the limits of monumentality. On his visit to St Peter's in 1786 Goethe — the German — described his impression thus: 'In St Peter's I have taught myself how art as well as nature can dispel all sense of proportion and relative scale.'

The key monument for understanding the development of Renaissance house-building is the Medici Palace in Florence (Figs 23 and 24). Its architect, Michelozzo,

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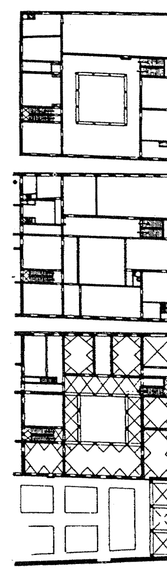
Fig. 22. *Rome. S. Pietro (Michelangelo* et al.*, finished 1646: watercolour by Louis Haghe, 1864)*

Fig. 23. *Florence. Palazzo Medici (Michelozzo, begun 1444)*

Fig. 24. *Florence. Palazzo Medici: plan*



took over Brunelleschi's designs in 1444 and made substantial changes. Typical of its time is the overwhelming stress on the façades: though they contain only three storeys, the house towers above its four-storey neighbours. Any details reminiscent of earlier fortresses which still lingered among its contemporaries are here superseded by a civic,

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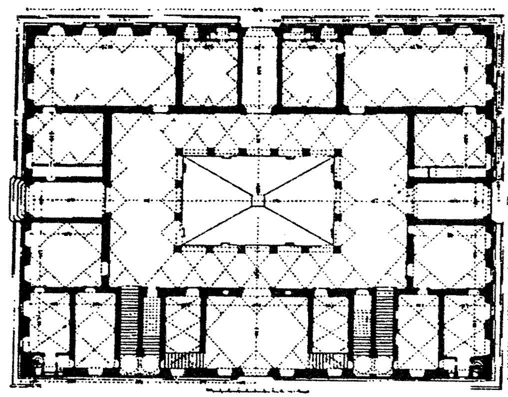

Fig. 25. *Florence. Palazzo Strozzi (B. da Maiano, begun* c. *1490); plan*

Fig. 26. *Florence. Palazzo Strozzi: cortile*

haughty elegance: for the three storeys, their height diminishing from bottom to top, coarse rustic, plain rustic, plain wall. The new *haute-bourgeoise* attitude colours the court also, which has altogether abandoned the medieval character of a working place: instead a monumental symmetry of uniform arcades rules. The interiors, however, are not subordinated to the new ideas: Cosimo de Medici allowed his architect to retain the plan of the traditional family house with its practical arrangements for private family life and absence of formal magnificence. It was only in the next generation that rich Italian families let their architects organize their palaces entirely according to new ideals. The Strozzi Palace of around 1490 is everywhere regulated by a thorough going symmetrical monumentality: no trace is left of a medieval way of living, few signs of privacy, no sign of work (Figs 25 and 26).

From about 1500 symmetry and grand perspective come increasingly to dominate Italian palace-building. The apogee of this movement comes in the seventeenth century when Pope Urban VIII commissioned the building of his new palace from the plans of three architects — Bernini, Borromini and Pietro da Cortona. The Palazzo Barberini (Figs 27 and 28) stands in a park on the very edge of seventeenth-century Rome; so the masters could plan it freely, its character half-way between palace and villa. The façade is richly monumental: the visitor's way in leads through a half-open bottom storey to

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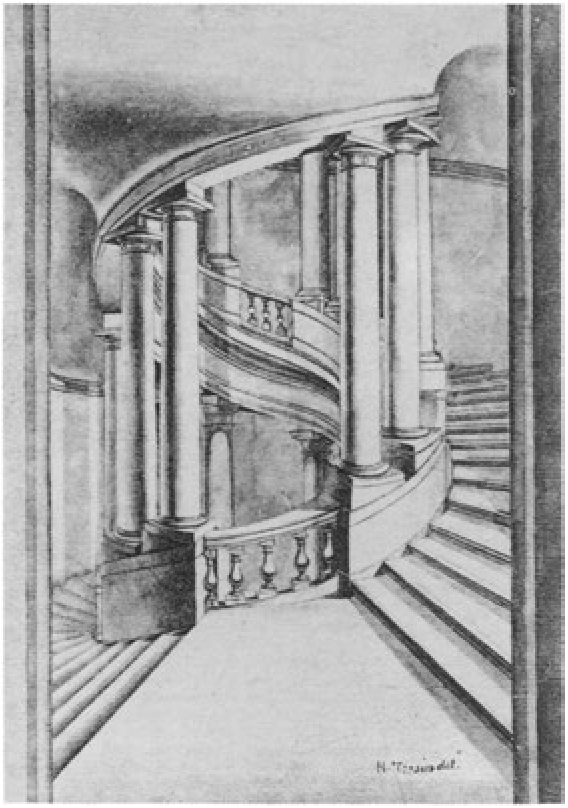

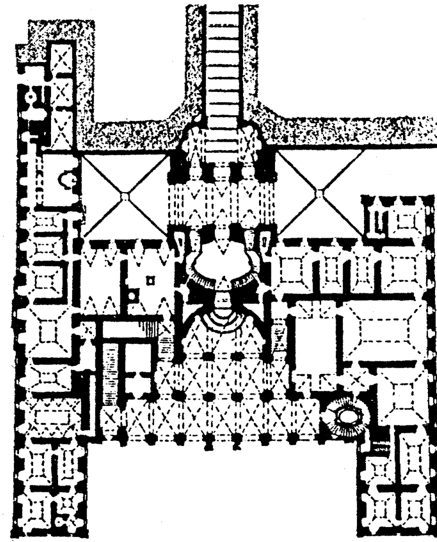

Fig. 27. *Rome. Palazzo Barberini (Bernini & Borromini, 1620-c. 1645): oval stair*

Fig. 28. *Rome. Palazzo Barberini: plan*

two vast staircases, one square and one oval, each emerging into a separate ante-room to the *gran salone* which occupies two storeys of the façade in the middle of the building. The gobelins and much of the other decorative apparatus have gone, but the overwhelmingly powerful ceiling is intact, marking the summit of papal magnificence. The deep cove curves up above the framing cornice, giving extra depth to its great *trompe-l'œil* painting, an encyclopaedic illustration of the grandeur of Urban as the great mediator between God and Humanity. In order that the exceptional importance of Urban should not be overlooked, Master Pietro introduced the papal coat of arms at the centre of the ceiling, modernizing the symbolism by replacing traditional heraldic characters with three flying bees seen against a blue sky (Fig. 29): bees are images both of divine Providence and of the Barberini family. Pietro was able to depict the insects with naturalistic accuracy by using a contemporary engraving from a scientific treatise on apiculture dedicated to Urban. Its extraordinary biological precision is due to Francesco Stellato's use of the microscope for observing animals for the first time in history in 1623. Stellato was a pupil of Galileo Galilei. So it happened that Pope Urban allowed his painter to use microscopic observation for glorifying his papal person, the same pope who threatened Galileo with torture if he did not abstain from proving the truth of the Copernican solar system by the aid of his other instrument, the telescope.

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Fig. 29. *Rome. Palazzo Barberini: gran salone, ceiling (P. da Cortona, c. 1640)*

Fig. 30. *Francesco Stellato:* Melizzografia, *titlepage (1625)*

Fig. 31. *Paris. Ste Geneviève (Panthéon: Soufflot, c. 1755–80)*

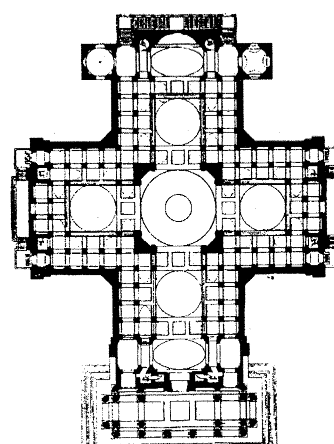

Fig. 32. *Paris. Ste Geneviève: plan*

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Enlightenment and Revolution

Throughout the eighteenth century professionals and amateurs in many fields of society brought about ever-increasing changes in their work and their thinking against a background of the development of agricultural and industrial economy. Enlightenment, la lumière, consciously or unconsciously, was their spirit. The French Revolution eventually became the all-embracing symbol of the whole process of events.

To help us to understand what happened in architecture at this period the Panthéon in Paris is most eloquent. Jacques-Germain Soufflot began it in 1750, under Louis XV, as the church of St Geneviève, the patroness of Paris. It was finished under the Revolution as the Panthéon, the Temple of Reason (Figs 31 and 32).

The architect's task was to create a congregational building in an age when even theologians were denying the possibility of creating visual images of the Supreme Being or churches as places set apart as sanctified. He had therefore to create a building monumental in its own right with few traces of religious symbolism, as it were an autonomous architecture. For his grand œuvre Soufflot gathered together a congeries of ideas and skills to serve an encyclopaedic ambition which was inevitably eclectic. He went into every aspect of the work with the greatest care. For the formal language he adhered to the principle of a many-sided choice among the historic styles that were emerging in his time. Roman antiquity was still dominant; Soufflot, however, was not satisfied with the general patterns in the books of Alberti and his numerous followers through four centuries: he had sharpened his understanding by travelling in Italy and could use his own first-hand sketches and measurements for many details. Simultaneously he was also inspired by the classicism of the Roman Renaissance, and for the superstructure of St Geneviève he chose, as a free paradigm to dominate this part of the Paris townscape, Bramante's puristic Roman Tempietto at San Pietro in Montorio. Nevertheless classicism was no absolute doctrine with Soufflot: he also selected features from the Gothic of his own country, on which he had lectured in his early career, as for example the flying buttresses (hidden behind the upper outside walls) and — literally above all and emulating the atmosphere of a Gothic cathedral — the explosion of light through the complex glazing of the superstructure, with its triple-shelled dome.

The Panthéon's one decisive contribution to the general development of architecture lies in its inner planning and the distribution of its rows of columns. These are of the same order as those on the entrance façade, but within they take on a new role, joining with pilasters to frame a Greek cross and leaving behind all traces of the tradition of nave and aisles. (Did Soufflot know of Wren's Greek cross plan for St Paul's, whose buttressing and dome structure he so evidently studied before designing his own church?) The columns assemble the interior space under the central dome: rationalism and equality have replaced the age-old liturgical order of Christian hierarchy. Rationalism pervaded the fine detail throughout the building: all lines are sharpened, capitals, friezes, soffits delineated with a uniform precision often seen as mechanical and dry. Architects of the Enlightenment had come under the influence of the machine-builders, and this changed completely the conditions and position of the craftsmen artisans, who were now forced to adhere closely to the architects' drawings

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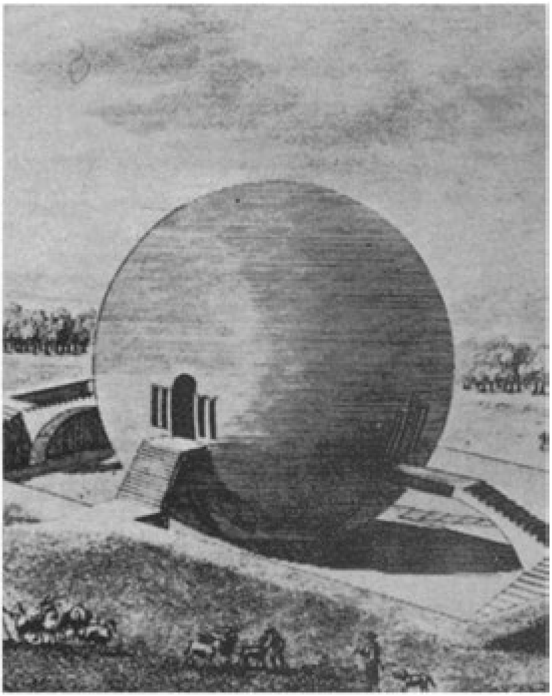

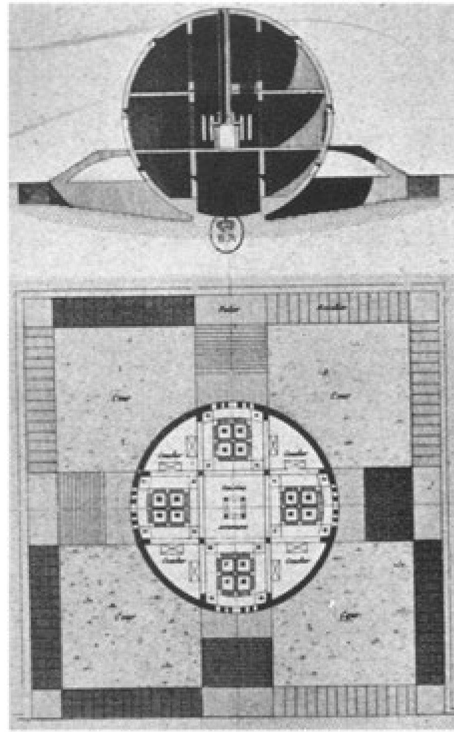

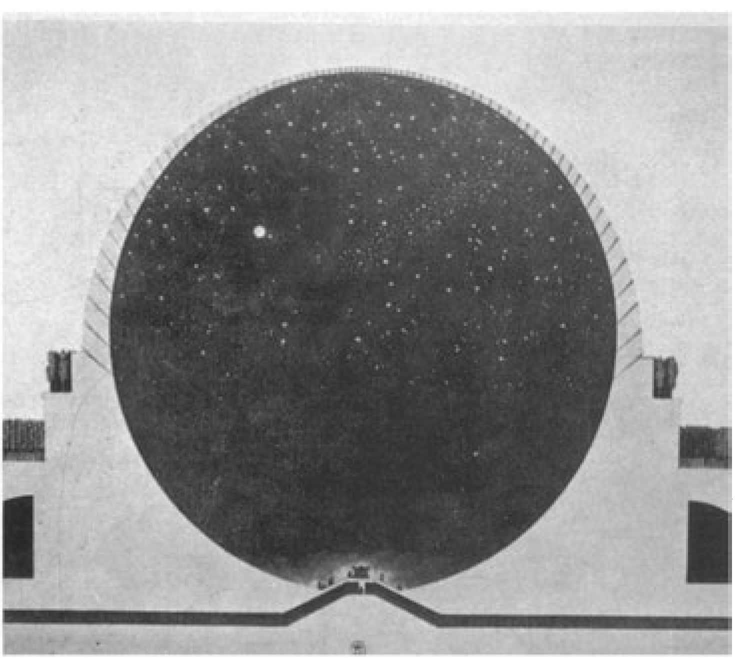

Fig. 33. *Maupertuis. Guardhouse (project: Ledoux,* c. *1780)*

Fig. 34. *Maupertuis. Guardhouse: section and plan*

Fig. 35. *Boullée: project for monument to Newton (1784), section*

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and were thus deprived of making a personal contribution through their own handicraft. Furthermore Soufflot introduced into the construction of the Panthéon techniques not common in the architecture of his age: to build the complicated dome he called in the assistance of the skilled engineer Jean-Baptiste Rondelet, who worked iron rings into the masonry to meet the vertical forces and reduce the overall weight.

The Panthéon is unique. As a monument it had few successors: it came to seem artificial to attempt to crowd so many distinctive aspects within a classicist frame. Yet all of them were symptomatic, each reflecting a separate tendency. In that age of liberated forces, however, architects and engineers developed each feature independently, with no recognizable influence from the Panthéon — the liberation of internal planning, the choice of style, iron technology, methods of drawing and design. Often aspects were combined but never again so totally subordinated within a classical framework.

Of all the movements launched in the Panthéon the transformation of internal space has been perhaps the least studied, though it was all-embracing, the very key to subsequent conceptions of planning. The radicals, with Ledoux in the lead, made the vital step whose importance has been strangely underrated. They developed classicism into an extreme tendency of the absolute and autonomous, as in Ledoux's famous project for the agricultural guards at Maupertuis (Figs 33 and 34): externally a sphere, a visual symbol of the rational; and this reduction of the outside to the purest and simplest form has its counterpart within, where the compartments are neutral, rejecting all baroque conventions and allotted their functions as it were second-hand. This radicalism should not be seen as merely a passing fancy, though it was rarely practised in its intransigent extreme. In fact it was the releasing, but often disregarded, intermediary between the tradition stemming from the Renaissance and modern planning. Around about 1800, especially in the designing of English villas, it was liberated from its extreme severity into a mature inner differentiation of functions, the very crucial principle of nineteenth- and twentieth-century architectural planning. Unless we take the intermediary achievement of the radicals into due consideration, our whole conception of the emergence of modern architecture will remain lopsided, and the transformation an inexplicable metamorphosis.

Parallel to the development of space differentiation, the radicals could also speculate about magnifying monumental interior space. Boullée's famous project for a cenotaph to Newton (Fig. 35) was not directly influential but is fascinating as a manifestation of eighteenth-century architects' ambitions to develop a new understanding of space. His design, like those of Ledoux, excluded all classicist elements, decorative or otherwise. Instead Boullée employed the visual symbols of geometry to create monumentality unqualified and uninterrupted. For the interior he proposed a hemispherical ceiling representing the northern sky at night, leaving openings for daylight to pass through at the positions of the stars: his aim was to suggest the endless immensity of our visual world. Thus Boullée exchanged the traditional concept of the sky as a vault for the astronomers' concept of the endless universe, indeterminable and distanceless. As an analogy he invoked a person at sea who can perceive only endlessness or a traveller in an 'aerostat', a balloon of the type invented by his contemporary Montgolfier — again someone placed to see the endless and nothing else.

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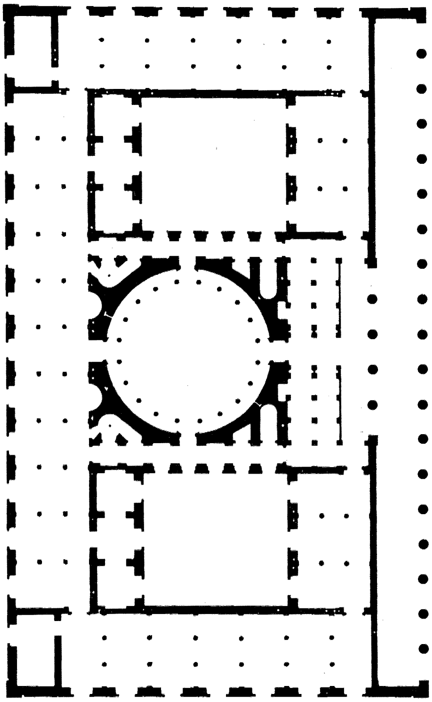

Fig. 36. *Berlin. Altes Museum (Schinkel 1824–28): plan*

Freedom of choice among the styles had already become a possibility for architects in the eighteenth century but was not seriously taken advantage of until the 1820s. A comparsion between two famous monuments can show how the choice could be enacted, for the architects of both could justifiably be called bilingual, masters of both classicism and the medieval. For the Altes Museum in Berlin (Fig. 36) Karl Friedrich Schinkel laid out a plan with a monumental hall at its centre and rooms on either side distributed in strict symmetry in two storeys. The main façade is a long stoa, in regular Greek Ionic, horizontal in character since the architect held that vaulting was alien to the Greeks. The central hall, however, is manifestly Roman, covered with a Pantheon-like dome. Westminster Palace in London has a plan similar in principle to that of the Altes Museum — at its centre a monumental hall flanked by the twin domains of the House of Commons and the House of Lords, north and south. The option of Gothic for the entire project must have come in handy to Barry, by education a classicist: the complicated structure of Parliament made it necessary to build in much asymmetry, something common in Gothic times but incompatible with classicism and even with the Elizabethan style, the alternativeallowed by the competition rules. As a partner the classicist Barry called in Pugin, fantast of the Gothic. Even if there is some unGothic repetition in the motifs of the façade facing the Thames they are nevertheless Gothic. More decidedly so are the two unequal towers as dominating accents of the exterior, and so especially is the interior architecture of the central hall, the communication point and symbolic meeting place of the two Houses. Choice of style was the constant subject of discourse among architects of the nineteenth century, in many countries even longer.

The most spectacular novelty of the age following the Panthéon is the widening, we might even say the exploding, of the limits of interior space brought about by iron construction in large halls for many uses — markets, stores, riding schools, hothouses, exhibition halls, railway stations. Historically we can in a sense see these iron structures as the realization of Boullée's dreams of making interiors create an image of the immense, the limitless. Such was the development of the court at the Halle au Blé in Paris when the community needed more space for the storing of seeds than there was room for in the existing building dating from the 1760s (Figs 37 and 38). The architects Le Grand and Molinus began by extending a device invented by the sixteenth-century master Philibert de l'Orme who met the increasing scarcity of large timber by linking

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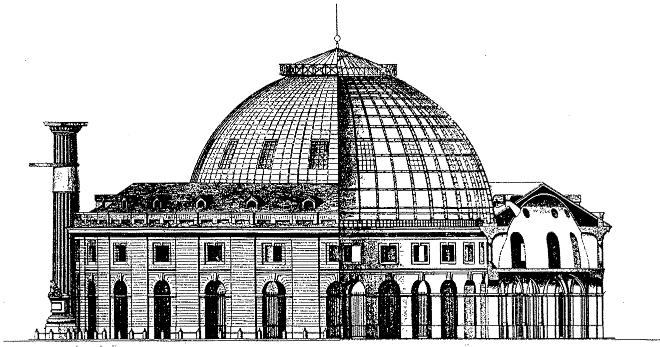

Fig. 37. *Paris. Halle au blé (Bélanger and Brunet 1809–11): elevation and section*

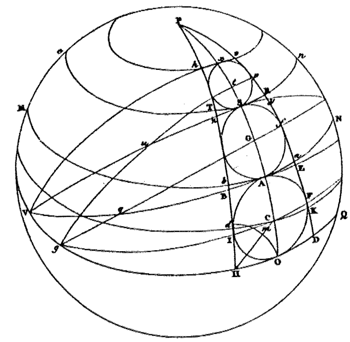

Fig. 38. *Paris. Halle au blé (geometrical drawing by Brunet)*

together small pieces of high-quality timber in order to raise large and light vaulted roofs.

The first dome of the Halle au Blé burnt in the 1790s. Then the architect Bélanger and his engineer colleague Brunet, schooled by the great geometer Monge, managed to construct a cast-iron dome, a fine net of ribs and rings with glazed openings. Brunet used spherical geometry to calculate the form of the many hundred iron members with a precision that would have seemed pedantic had the structure not been experimental. The idea of calculating the shape of the dome was, in itself, the most decisive change in architectural drafting since the Pharaonic masters of Egypt started to draw at least five millennia earlier. The next great step was soon taken by the iron builders when they came to make precise calculations not just for the outer form of their buildings but for their inertia.

However, the foundry tradition remained adequate for much iron construction during the first half of the nineteenth century — for factories, hothouses and many other types. The last triumph of this tradition was Joseph Paxton's famous Crystal Palace — for the first world exhibition of industry but designed by a garden architect: 600 metres long, all framed in cast iron save, in its executed form, for the wooden-arched transept at its centre. All the glazing was of blown glass cut into sheets. The many lithographs and paintings of the Crystal Palace show a special feature that enlivened the whole interior: colour. Paxton had the wisdom to collaborate with Owen Jones, the leading master in his age of architectural colouring: his painting in carefully chosen proportions of blue and yellow added to red textiles liberated the interior from the prosaic look of many other iron halls.

The Crystal Palace, in all its glory, was a latecomer in the development of iron-hall construction. Many architects and engineers, individually or collaboratively, had already invented lighter and more airy structures for their large roofs. Far advanced, and widespread around the world, were, and still remain, the simplified roof trusses invented by the Frenchman Camille Polonceau. They still cover many railway stations, riding schools, warehouses and factories the world over. Like many other structural types, they were the outcome of the widening use of accurate calculation

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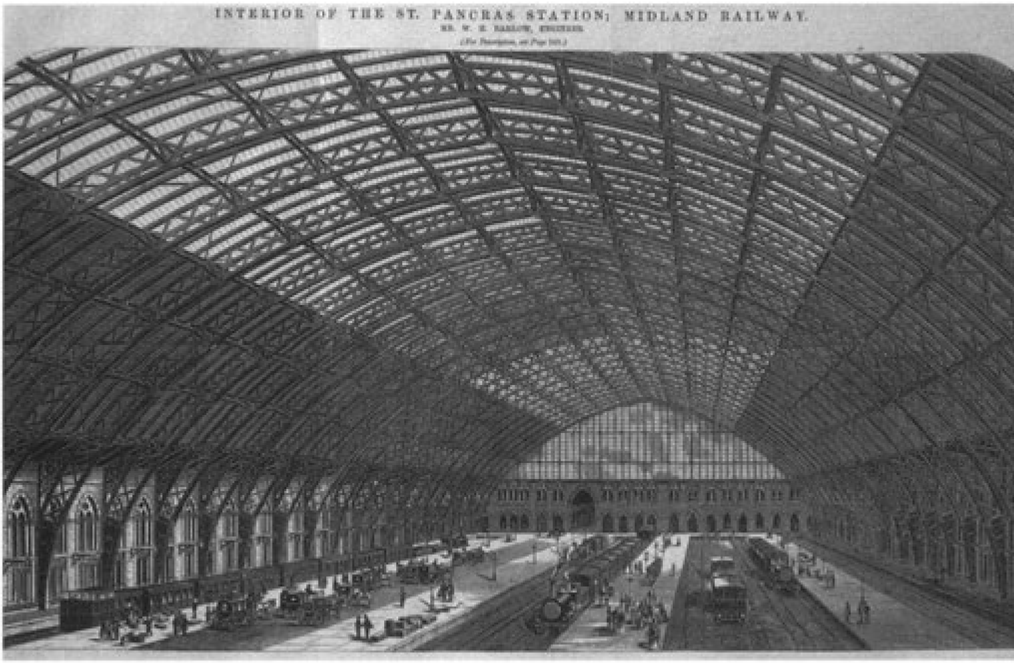

Fig. 39. *London. St Pancras Station: train shed (Barlow and Ordish, begun 1863)*

after *c.* 1820, especially by the Frenchman Louis Navier, who made the definitive statement of the principle of scientific inertia as the fundament of all building theory and calculation. Before his time statics alone was scientific; Navier introduced the calculus of elasticity as its complement. By its means he, and all his innumerable followers, have been able to acquire reliable knowledge of how structures keep together and not simply, as before, of how they break apart. For the first time in history technological theory was brought to such a degree of comprehensiveness that it could serve as a reliable basis for the practice of any skilled engineer or architect.

The extent to which builders could develop large interiors in the nineteenth century was bound up with the rapid extension of iron vaulting. The vault over St Pancras station in London (Fig. 39, begun in 1863) enclosed what was then the largest volume in history, superseding by far both Hagia Sophia and St Peter's. But its structure was tied to the conception of arches as segments of circular forms. The great liberation of large interiors from their dependence on geometry came about through the collaboration of two Frenchmen in creating the Palais des Machines (Fig. 40) at the world exhibition in Paris in 1889, the year which also saw the triumph of Eiffel's 300-metre tower. The masters of the machine gallery were the architect F. C. L. Dutert and the engineer Victor Contamin. Combining their skills in the most creative manner, they built an architectural masterpiece, whose interior more than doubled the volume of the train shed at St Pancras. They admitted that they had broken free of many formal prejudices about the possibilities of building on a large scale by arriving at the design of their arches by artistic intuition instead of sticking to geometry. The

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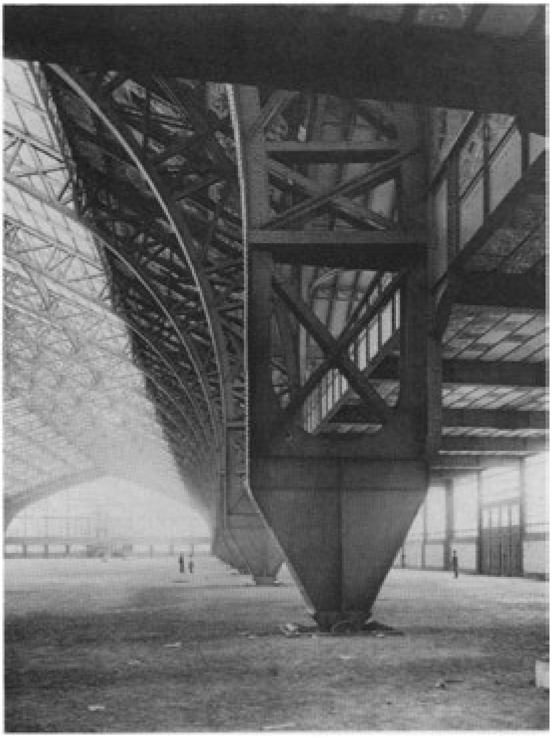

Fig. 40. *Paris. World Exhibition: Palais des machines (Dutert and Contamin, 1889)*

profile of their trusses is essentially a four-centred arch resting on ten-metre high vertical posts, the two halves of each truss treated independently and jointed at the top as in the manner of a cruck. To avoid monotony the lattices of the trusses are made of alternating wide and narrow cross-braced panels. Instead of building enormously high to lead the eye to the heavens as medieval builders had done, Dutert and Contamin stressed breadth to direct attention to the ground, to the exhibits, the great parade on the floor of machinery from so many nations.

Modernist Tendencies since the 1850s

The masters of the Palais des Machines brought their century's protracted concurrence of attention on the large interior to its quantitative climax. More important, however, was their qualitative mastering of till then undreamt-of size by giving their architecture far more artistic expression than earlier iron building had attempted. It was in so doing that they adhered to the general artistic tendency of their age accurately entitled expressionism. Expressionism opened up a more direct relationship between the ends and means of the artist's work: it meant abolishing such obstacles as exaggerated naturalism in painting, or in architecture the insistence on a grammar of style, on symmetry or the rules of scale.

Among the first to open up new ways in nineteenth-century building were Philip Webb and William Morris in Morris's famous villa, the Red House, in Kent, 1856.

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They shifted their age's marked interest in history from the choice of style to traditions of handicraft in brick, stone and wood, both by revival and invention. By combining this interest with a concern with family life they reformed house-planning from its dominance by the demands of social display to a concentration on everyday use and the handicraft work which had been constantly kept at bay since Renaissance times.

Artistic simplification was an urge that many artists in different professions had in common towards the end of the nineteenth century; it was the innermost inclination of their senses, emotion and intellect. At the turn of the century many architects, artists and artisans kept their interest in decoration when they left historic styles behind and invented a new style to be an adequate expression of the new age. They called it Jugendstil in Germany, Sezession in Austria, Liberty in Italy and Art Nouveau in France and Britain. We had better call it rather a fashion than a style, even if it was widespread and lasted from the 1880s until 1920. In the hands of a master it had to do with more than mere surface: expressionism and simplification were stronger forces in the greater personalities. Louis Sullivan in Chicago, especially with his Auditorium Building of 1886–89 and its magnificent interior, opened radically new possibilities. A huge gallery, repeating the plan form of the stalls, reaches far nearer to the stage than in conventional theatres, and the shape of the interior was worked out according to acoustic observation in numerous positions. Ornamentation is sparse in comparison with the many overdecorated interiors of its time; the building has even been considered as the precursor in simplicity of the succeeding functionalist age.

Outstanding among the great monuments of simplification in the early twentieth century is the Stockholm town hall, built between 1911 and 1923 under the influence of Morris's ideas after earlier Art Nouveau designs had been abandoned. For his free composition of exterior volumes and inner space, the architect, Ragnar Östberg, drew on impressions gained from travels in Sweden and Italy: the red brick south front, very sparsely decorated, stands with its tower mirrored in the waters of Stockholm in a way to suggest both north and south in the European tradition. The walk inside, through the deliberately modest portal passes the main court and leads by a broad staircase in the tower to the suite of the representatives of the Swedish capital, halting in fulfilment in the subdued light of the daring Golden Hall, its walls covered with glittering mosaics reminiscent of Byzantium. The walk ends in a masterly staged dissolution, when a row of glazed doors open the vista to the light and lofty atmosphere of the Blue Hall (Fig. 41), the grand festival hall, one of the triumphs of early twentieth-century simplification: its finely wrought red-brick walls give the impression of a magnificent piazza, transplanting to Sweden the architect's experiences of Venice and Verona. Only an instinct of singular artistic purity could enable the architect to master and fuse the open eclecticism and seemingly disparate features of Stockholm town hall.

Now what was the main field of activity for this great architectural-artistic simplification? The obvious answer is: concrete. This material, known millennia ago by the Greek colonists around Neapolis, that is Naples, and, still in antiquity, used by the Romans for example for the Colosseum and the Pantheon, had found limited use in other parts of Europe, dependent as its craftsmen were on the discovery of volcanic puzzolana around Vesuvius. Its first more widespread use did not begin until the late

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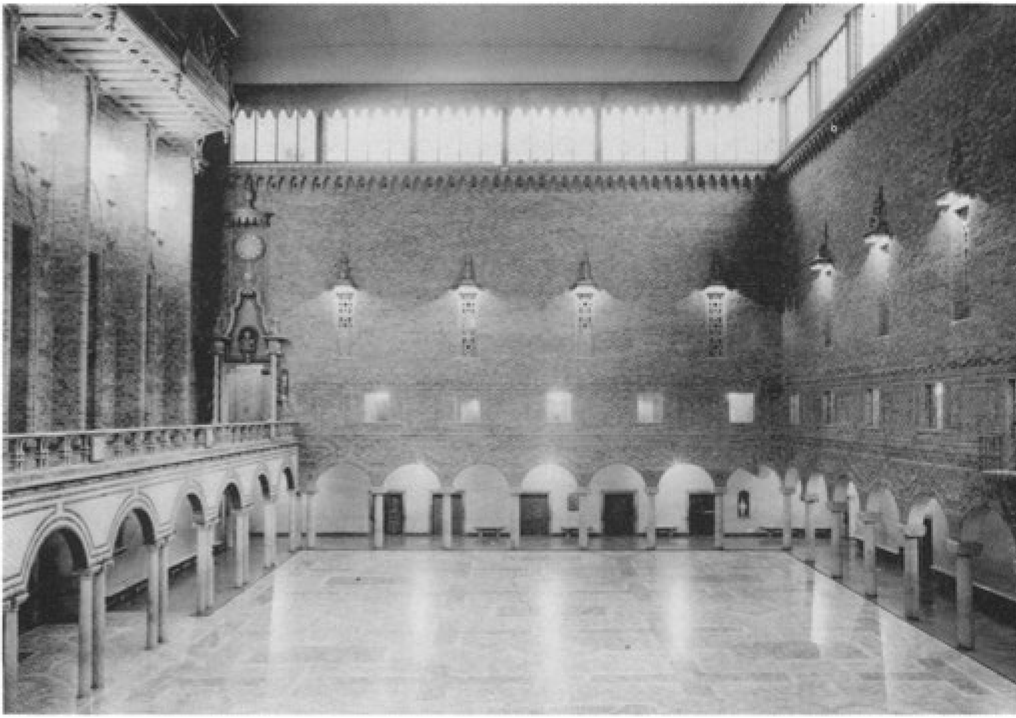

Fig. 41. *Stockholm. Town Hall (Östberg 1911–23): Blue Hall*

eighteenth century, when British and French engineers invented methods for making concrete in any country and on an industrial scale. But for a century from the 1790s onwards it was mostly used in blocks as a substitute for brick or stone, and mostly in harbour quays because of its resistance to water and the ability to cast it in large quantities. Not until the second half of the nineteenth century did inventors enter new alleys by experimenting with iron reinforcement in concrete. During the years between about 1850 and 1900 their work chiefly proceeded by trial and error, starting from the hypothesis that the two materials together could attain both the compressile strength of stone and the tensile resistance of iron. A few projects, though, gave an inkling of something maturing architecturally. The Frenchman Anatole de Baudot had been in his early years a follower of that fatally overpowering restorer of Gothic churches, Viollet-le-Duc — even to the point of imitating medieval styles in new churches. On the death of his master in 1878, however, when he himself was already forty-five, de Baudot managed to emancipate himself to a surprising degree. He became one of the pioneers of reinforced-concrete architecture. In an almost futuristic project in 1894 for a hall at the Paris exhibition of 1900 he created, on paper, one of the first great reinforced-concrete interiors, intending to use the method developed by the experimentalist Cottencin, mostly in reinforced pillars and blocks (Fig. 42). The sketched project was meant to enclose a large and lofty space with unusually high pillars carrying concrete slabs in rings diminishing upwards into the vault and distantly

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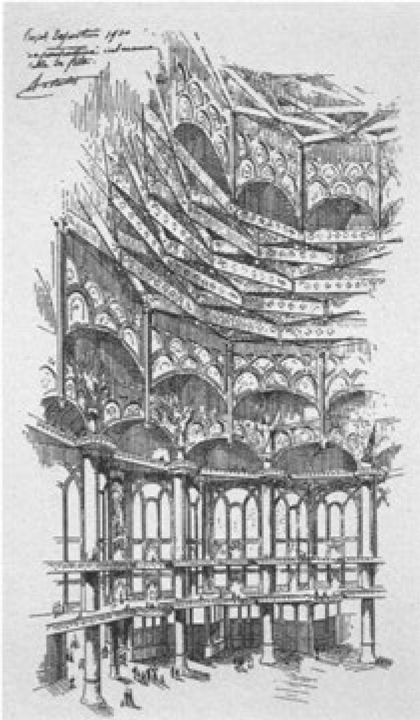

Fig. 42. *Paris. Exhibition hall (project: de Baudot 1894)*

resembling the vaults of Saljuk monuments. Since the technique of reinforcing was still tentative and uncertain the project may have seemed Utopian, but it was bold and promising in its monumentality, a worthy contribution to the design of great exhibitions, that fantastic pioneering field of nineteenth-century architecture.

De Baudot never seems to have given up Cottencin's method. When he built his famous St Jean de Montmartre (1898–1904), he drew the iron rods through hollow exterior tiles and used Cottencin pillars, slabs and ribs for an interior that bears all the signs of being an experiment. With all his audacity de Baudot never seems to have grasped the decisive technique of reinforced-concrete building. That was the many-sided achievement of François Hennebique, the Franco-Belgian engineer who in a patent of 1892 announced the first really scientific conception of the interaction between cement and iron in building. His was the solution of the monolithic 'one-stone' behaviour of the two materials together. Hennebique was not only an unusually experienced builder; he was also a skilled mathematician, mastering both statics and elasticity, the essential theoretical conditions for handling reinforced concrete adequately. From now on builders could teach themselves not only how to calculate but also the limiting properties of reinforced concrete.So it was chiefly the inventions of Hennebique and his followers which, against strong initial resistance (he was not allowed his initial patent), released its enormous and multifarious capabilities. The difference between those parts of the building that were carried and those that did the carrying — by loading or hanging — was eliminated, and all elements of a structure were kept together without joints — pillars, lintels, slabs, decks, walls. Especially new were continuous integrated bodies (*Körper*) and shells.

Among the architects who soon realized the architectonic possibilities of reinforced concrete was the German Max Littmann. In 1905 he built the Institute of Anatomy in Munich: with pillars, arches, domes and ribbed vaults he set an early example of the straightforward and expressive use of reinforced concrete in creating artistically new and self-dependent interiors. A clear instance of the assumption of monolithic behaviour is the Ebers factory for industrial clothing created by the brothers Auguste and Gustave Perret in 1919 (Fig. 43). Over the huge central space they set slender concrete arches which support a vast flat glass roof allowing natural light to flood both the main floor and the double-decker galleries, the whole hanging together in one continuous concrete construction. A critic pointed out that the architects had achieved

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Fig. 43. *Paris. Ebers clothing factory (A. and G. Perret 1919)*

the remarkable simplicity of the entire fabric by following the unwritten rule 'to make the most by the least'. This of course in terms both artistic and of structure and economy.

Reinforced concrete, as the builders of the twentieth century have demonstrated, serves all types of building — the elaborate coherence of house-planning as well as the synthesized design of large halls. To realize how far architects were ready to develop house-building by full-scale experiments with reinforced concrete we can consider the work of Le Corbusier as an intermediary. In his epoch of influence from about 1914 until his death in 1965 he acted as the radical experimentalist of reinforced concrete, often reaching and even transgressing the border of the utopian in a manner reminiscent of Ledoux. Historically we should value his works above all for their demonstration and opening up of possibilities, a quality that can sometimes be more influential than executed examples. Corbusier's projects are all solutions of artistic problems synthesizing rational analysis and intuition. It was one-sided of critics to accuse him of pure rationalism: 'intuition', he wrote, 'acts by unexpected lightning'.

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Clearly he was alluding to himself — we may regard it or not as arrogant self-reliance — when he wrote: 'Life summons the poets that the time needs.' As to his opposition to passing fashion, he laid it down that 'architecture has nothing to do with styles'.

Among his executed projects the villa at Garches (1927) (Fig. 44) is most enlightening, both in itself and in the master's eloquent description of it. Here piers are welded with decks into a continuous four-storey structure: the pillars act as fixed regulators, standing in rows 'like soldiers'. So Corbusier could plan screen walls and staircases with complete freedom: he saw the plans of the run-of-the-mill buildings of his own age as 'enslaved by walls', whereas he could open or close plans according to the needs of the inhabitants, varying them from ground floor to roof terrace. And windows could stretch from corner to corner, since all structural piers were distanced from the hanging screen walls of the façade: 'reinforced concrete marks a revolution in window history.' The planning principle we should call inner flexibility, another advance comparable to the inner differentiation introduced by Ledoux and his generation.

The extraordinary aesthetic simplicity of façades and interiors was not an end in itself, though Le Corbusier was obviously an adherent of cubism, the manner that had taken the stylistic lead after the constructivism of the iron builders. It was Corbusier's ambition that the great artistic simplification should have a social end: he wanted to give radically new directions to bourgeois life and work, abolishing hierarchical patterns. So, in rebellion against middle- and ruling-class habits, he pursued in France some of the ideas that Webb and Morris had introduced in England sixty years before.

Decades before Le Corbusier's penetrating intuition demonstrated the possibilities of reinforced concrete for the building of houses, the Swiss engineer Robert Maillart had lifted the new material on to its mature artistic level, chiefly in his numerous bridges in his homeland but also by demonstrating its manysidedness in large stores and other halls. Maillart stood out as the recreator of the pillared interior. His most important invention was the mushroom column and its integration with the slab into an exquisitely finished whole. By abandoning traditional dependence on constructions of wood, stone, steel and concrete blocks, he revealed the innate properties of concrete with its reinforcement, and led both colleagues and the public into a far deeper appreciation of the great technical and cultural value of reinforced-concrete building. Through his singular ability to combine scientific and literary acumen in describing his work, he is able to tell us step by step how he attains his ends: his way of working was a rare combination of mathematical, technological, economic and artistic-architectonic gifts, using intuition for both criticism and creation. When he discovered shortcomings in inertia calculation and illusory perfection, he turned to tentative scientific experiment, seeking to unite all seemingly disparate procedures. The distinguishing quality of his pillared interiors for industry, stores and other prosaic uses is an extraordinary architectonic simplicity, with plain, open vistas, the only accents being the undecorated contrasts between slabs and columns, with mushroom capitals as self-evident intermediaries.

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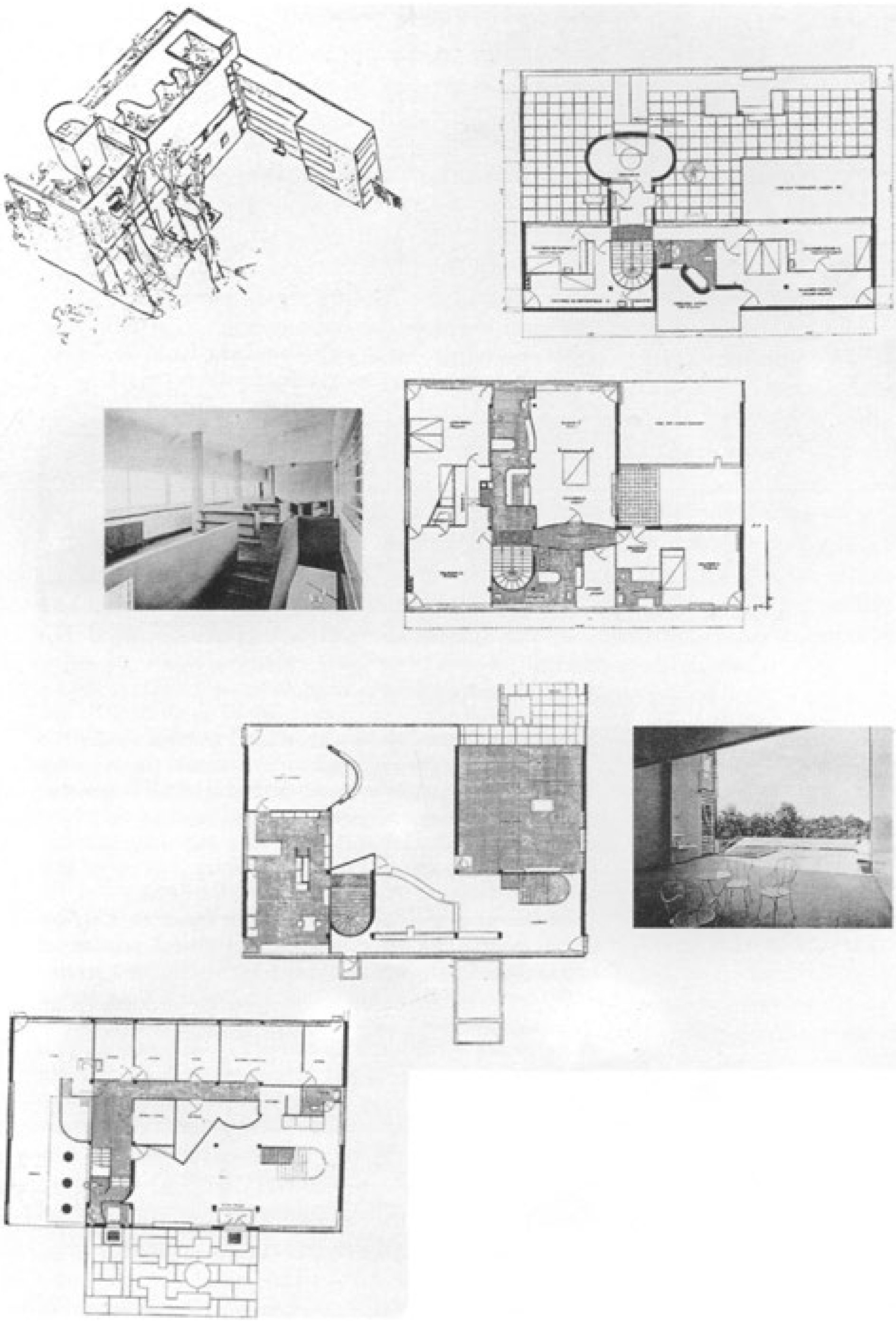

Fig. 44. *Garches. Villa (Le Corbusier 1927): plans and perspective*

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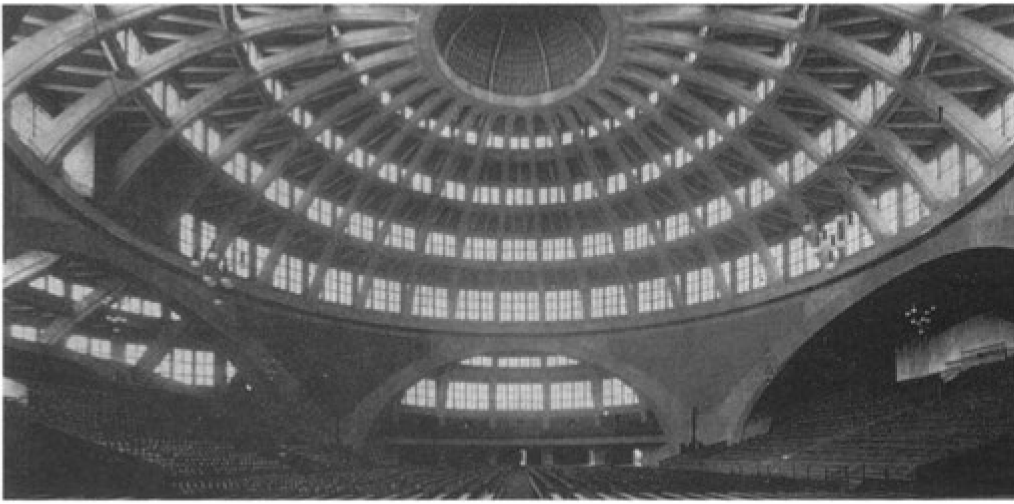

Fig. 45. *Wrocław (Breslau). Jahrhunderthalle (Berg 1911–13)*

Some of Maillart's pioneering work in Switzerland and Russia dates from as early as 1910. Throughout the century architects and engineers have followed his lead in finding new ways of meeting old as well as new demands. One of the first really large reinforced-concrete halls was the Jahrhunderthalle (now called the Hala Stulecia) in Wrocław, formerly Breslau, built for the exhibition of 1911 and designed by Max Berg, a pupil of Hans Poelzig (Fig. 45). Within an outer circle 96 metres in diameter, great segmental arches carry a 67-metre circular ring, from which spring segmental ribs intersected by diminishing rings ending at a small domed centre; above each ring is a continuous wall of glass flooding the interior with light: arguably the boldest use of reinforced concrete before Nervi. Equally adventurous were Freysinnet's enormous hangars at Orly built in 1916 for the dirigibles. The engineer used large prefabricated reinforced-concrete arches to enclose the huge volumes needed by the airships.

Such buildings were no more than an episode in the development of the material. Another interesting episode came with the planetaria initiated by Carl Zeiss in Jena for his popular lectures on astronomy. To serve the demands of projection the interiors had to be exact hemispheres: the problem of constructing shell domes was solved by erecting an iron net, within which movable wooden formwork was mounted and cement sprayed, zone after zone, from the exterior so that the netting became embedded in concrete. Relative to its scale the thickness of the dome was less than that of an eggshell. The visitor's view on entering was of something distanceless and totally empty; when the apparatus was functioning the illusion of the northern celestial hemisphere was striking: Boullée's dream of 150 years before was realized as a dynamic performance within half an hour of what happened in the sky during 26,000 years.

At the breakthrough of his career in the 1920s, Pier Luigi Nervi and his colleagues had more than thirty years of concrete experience to benefit from, above all the œuvre of Maillart. Nervi was another intuitionist, who used his innate artistic sense to master the problems of erecting large roofs of a bold and novel form by mounting

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Fig. 46. *Rome. Palazzo dello Sport (Nervi 1960)*

prefabricated elements with absolute precision, as in his aircraft hangars of 1935 at Orvieto. Later he used his almost unique combination of theoretical insight and intuition to raise enormous roofs of the most diverse kinds over sports halls, stadia, exhibition halls and industrial warehouses: the soaring skeletons or nets of his roofs give his interiors a decided stereotomic character (Fig. 46).

Among the largest of reinforced-concrete structures is the hall in Paris built in 1956–59 for the Centre Nationale des Industries et Techniques (Fig. 47). Six architects and engineers combined their skills to cover the exhibition space — an equilateral triangle with 206-metre-long sides — with a light concrete dome. They solved the intricate problem of the weight by constructing a double shell, pleated for both strength and elegant articulation. Consciously or not, five hundred years after Brunelleschi, the masters of the C.N.I.T. hall renewed his shell-building method to raise an architectural monument to modern French industry, enclosing a volume many times that of the Florentine dome with a fraction of its weight.

Everyone of course knows that, even if reinforced concrete was from the 1920s onwards the preferred material for large interiors, many architects and engineers used other materials. Ralph Tubbs used aluminum for the skeletal saucer covering the circular Dome of Discovery at the South Bank exhibition in London in 1951, as an invention to accommodate and echo the scientific and technological inventions displayed on the large floor. Outside, the asymmetrically-set low dome was buttressed by supports meeting at oblique angles, their upper and lower ends forming an original

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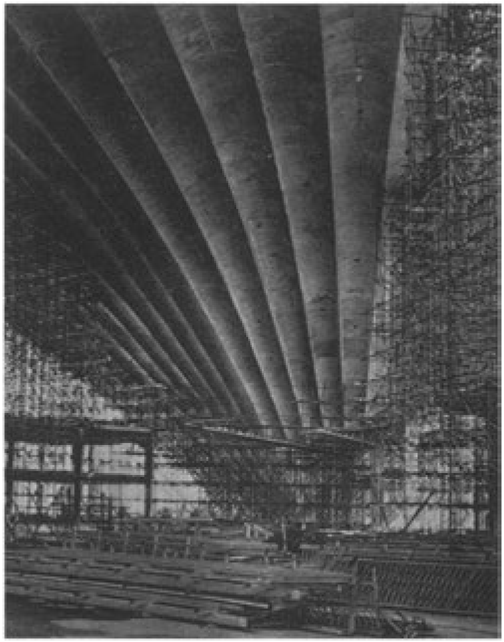

Fig. 47. *Paris. Centre nationale des industries et techniques: hall (Camelot* et al., *1956–59)*

Fig. 48. *Oulu. Public Hall (Harju and Heikkilä 1985–86)*

Fig. 49. *Oulu. Public Hall: interior*

pattern. In the early 1970s the large auditorium at the People's Palace in Shanghai became famous for its very large flat roof. Over an interior seating more than 10,000 people on its raked floor, concrete walls supported a 5,000-square-metre space-frame clearly visible from below through the acoustic fissures in the covering material. Its designers were members of the Faculty of Civil Engineering at Shanghai University.

Then in the 1980s came a Finnish triumph of inventiveness. The architect Risto Harju and engineer Pekka Heikkilä, supported by the Faculty of Engineering in their town of Oulu laid a shallow wooden dome over a large hall for feasts, concerts, sports (including football) and other interests (Figs 48 and 49). The circular concrete wall is only three metres high, the radius of the cupola 90.35 metres. Specially glued timber logs are mounted in small triangles within bigger triangles to form a straightforward visible pattern soaring over public and performers and enclosing a volume of over 150,000 cubic metres.

And that, for the moment, is where the story ends.

I should like to add a short postscript thanking Andor Gomme for his generous, concise and constructive bettering of the 'foreigner's English' of the original MS.

E.C.

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