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The Architectural History of Venice

Revised and enlarged edition

with
new photographs
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Yale University Press
New Haven & London
By the end of the thirteenth century the city of Venice was a true metropolis. The seventy or so principal islands of the archipelago, each one a separate parish, had been enlarged by drainage and reclamation until they coalesced to form a coherent urban organism, separated only by canals. By the 1330s, the population had probably grown to nearly 120,000 inhabitants, about the same figure as that recorded in 1969. Venice was then one of the largest cities in western Europe. It seems that only Florence, Milan, Naples, Palermo and, outside Italy, Paris were of comparable size.1

At this point we should therefore pause to examine the urban structure of the city, its peculiar problems and its unusual features. The earliest known plan of Venice, datable to about 1346, shows clearly that the city was already a compact 'land-mass', although the representation is extremely schematic (fig. 27). The plan seems to be based on a twelfth-century prototype, partly updated by the copyist.2 The only buildings shown are the more prominent churches and the crenellated enclosures of the Arsenal and Piazza San Marco. There are also some fortifications indicated on the landward side of the city. By this time there must already have been a network of streets (though these do not appear on the map) as well as canals. To a great extent the layout still survives today, but one can gain an even better idea of the character of Venice in the Gothic period from the wonderfully detailed and reliable bird's-eye view of the city by Jacopo de' Barbari, which is dated 1500 (figs 4, 31, 35, 83 and 87).3

Like other major European cities – London, Florence, Paris and Rome are familiar examples – the city of Venice is traversed by a principal waterway, in this case the Grand Canal, which winds in an inverted S-shape through the city. One could safely say that all important cities in medieval Europe had water access, since water transport was the cheapest method for conveying supplies and merchandise. In most cases, however, there was a clear demarcation between land and water, whereas...
Plan of Venice, c.1346, from the Chronologia Magna, redrawn from a twelfth-century original (Biblioteca Marciana, Venice)
obviously in Venice – as in some towns in the Low Countries such as Amsterdam – the whole city was criss-crossed by canals. A number of the original canals have now been filled in to make streets, but their presence is usually recorded in the street names by the words rio terà. The term piscina records a former area of water reclaimed later than the areas around it.

Like London, Venice had only one bridge across the main waterway. This was the Ponte di Rialto, situated at that most significant geographical landmark, the lowest bridging point – that is to say, the most seaward position at which a bridge could easily be built. It was also the uppermost point to which sea-going vessels could navigate. The original pontoon bridge was replaced at the end of the fourteenth century by a permanent wooden structure. This bridge came to a dramatic end in 1450 when it collapsed under the weight of crowds of spectators during the visit of Emperor Frederick III of Austria. The bridge was rebuilt, once again in wood, with a drawbridge in the centre, this time lined with shops, like the Ponte Vecchio in Florence. This picturesque structure is vividly depicted in Carpaccio’s famous painting of the Miracle of the True Cross dated 1494 (fig. 28).

The present stone bridge, built by an architect named (most appropriately) Antonio da Ponte, dates from the end of the sixteenth century (fig. 29). The importance of the Rialto bridge to the Venetians is indicated by the fact that the State had commissioned designs from architects as renowned as Michelangelo, Sansovino, Palladio and Vignola. Even da Ponte’s relatively sober project cost the huge sum of 250,000 ducats.

The first bridges over the smaller canals were also built of wood. Even today wooden bridges are still common in the city, although nowadays the walking surfaces are usually asphalted. Later, brick and stone bridges were also erected, built in a characteristic low arc, with broad, shallow steps. These early stone bridges – surviving examples can still be seen near the church of San Felice (fig. 30) and on the island of Torcello – had no railings at the sides. Until the eighteenth century, rival factions of workers used to have spectacular fist-fights on the tops of these bridges, with many of the less fortunate assailants toppling into the water.

The Rialto bridge continued to be the only fixed crossing point on the Grand Canal until the 1850s, when bridges were erected at the Accademia and the railway station. Anyone wishing to cross the Grand Canal at another point could avoid the detour to the Rialto bridge by taking a traghetto or gondola ferry. These traghetti (some of which still function today) were operated at thirteen different points along the Grand Canal. One of the traghetti even crossed beneath the Rialto bridge, to save people the trouble of climbing its steps. The English
traveller Thomas Coryate, writing in 1611, warned visitors against this particular crossing, claiming that:

...the boatmen that attend this ferry are the most vicious and licentious varlets about all the City. For if a stranger entret into one of their Gondoloes, and doth not presently tell them whither he will goe, they will incontinently carry him of their owne accord to a religious house forsooth, where his plumes shall be well pulled before he commeth forth againe.  

The *traghetto* jetties can be recognized by their waterside platforms
decorated with trellises of vines and lamps. Until they were largely superseded by the vaporetto service, the positions of the traghetto remained unchanged. It would be no exaggeration to say that the layout of streets, houses and shops was therefore just as much affected by their presence as by the positions of the city's bridges.

Again like London, medieval Venice had two important centres - the commercial centre on the island of Rialto and the political centre at Piazza San Marco. The episcopal centre at San Pietro di Castello never had the significance of, for instance, the Piazza del Duomo in Florence, or those of Milan or Pisa. San Marco and Rialto were the highest and driest of the marshy islands, and therefore provided the firmest building sites for the early settlers. Unlike the cities of London and Westminster, however, the commercial and political centres of Venice lay not on the same bank, but on opposite sides of the principal waterway. This gave even greater importance to the link provided by the Rialto bridge. The street connecting Rialto with Piazza San Marco, known as the Merceria was the most frequented thoroughfare in the city. As a result, there was a heavy concentration of shops in and around the Merceria. Nevertheless, in spite of the great importance of the route, it never became a broad, stately highway, since no wheeled traffic apart from hand-carts used it. To this day it is narrow, crooked and often badly congested.

This observation leads us to consider the very distinctive transportation system within Venice itself, and its effects on the planning of the city. To a modern planner Venice has certain utopian features. In particular, pedestrian traffic in the city has never been seriously threatened by wheeled vehicles other than barrows. Even before the days of the motor car, Venice was far quieter than other cities. Henry James remarked in 1882:

There is no noise there save distinctly human noise; no rumbling, no vague uproar, nor rattle of wheels and hoofs. It is all articulate and vocal and personal. One may say indeed that Venice is emphatically the city of conversation; people talk all over the place because there is nothing to interfere with its being caught by the ear ... The still water carries the voice, and good Venetians exchange confidences at a distance of half a mile.

In Venice pedestrians and goods traffic are conveyed on completely separate, overlapping systems. Obviously, the two superimposed communication patterns did not evolve completely independently. Every market had to have both land and water access. We see from de' Barbari's map that Campo San Polo, which was the site of one of the two principal weekly markets in the city (the other was in Piazza San Marco), originally had a canal along its curved side to transport goods to the stalls (fig. 31). Similarly, every important palace had to have water access as well as a street entrance. A canal mooring was needed to bring in supplies of food and fuel, and for loading and unloading merchandise when the owner was involved in trade. Until the nineteenth century, wealthy families would have owned at least one private gondola for their own use, as well as small flat-bottomed boats called sandoli for carrying goods. These were tied up at the characteristic decorated wooden mooring posts in front of the palaces. Although there were a few horses in Venice, the Venetian palace obviously had no need of extensive stables; and in Venice boatyards, or squeri, took the place of coach-builders in mainland cities (fig. 32). Horse-riding in the Merceria was forbidden in 1297; after that time riders used to tie their horses to a leafy fig tree at the Rialto end of the street.
The layout of the canals was determined by the natural position of the lagoon channels. Although these were altered slightly in the process of drainage and land reclamation, it was essential not to impede the natural flow of the tides, which was vital for the removal of sewage and debris from the canals. Regular dredging has always been necessary to prevent the silting up of the navigational channels, both in the city and in the shallow waters of the lagoon. For the earliest settlers, water was the only important means of transport, since the individual islands were too small for streets to have much significance.

In contrast to the canals, the layout of the pedestrian walkways seems incoherent. Venice is one of the few important medieval cities that had no significant Roman settlement on the site. Most Italian cities still preserve traces of the regular Roman grid pattern in their street plans, but Venice has few straight streets of any length. Indeed, the labyrinthine residential quarters recall the dense urban layouts of Islamic cities, familiar to Venetian merchants through their trading activities. Each parish was built up street by street around its own church and campo (literally a field, though by the time of de' Barbari's map most campi were paved) in the centre of each island.

Although archaeology in the city is problematic, a possible pattern of evolution in the structure of the city can be suggested. In the most ancient parishes, established before the transfer of the dogeship to the Rialto in 812, the society was almost entirely dependent on water transport. The most powerful families apparently lived around small enclosed courtyards, forming a cellular pattern, traces of which still remain—for instance in the area around San Giovanni Crisostomo (fig. 18). From the ninth century onwards, numerous land reclamation projects enlarged each of the islands until they began to coalesce. Moreover, the more open mercantile society that was evolving began to need land as well as water transport, to provide quick internal communication. By the thirteenth century, settlements were growing up in a linear pattern along continuous streets, such as the Salizzada San Lio (fig. 21), while the existing closed courtyards were linked by connecting passages. The typical parish campo is rectangular or polygonal in shape, with the church on one side and residential developments extending outwards along transverse streets (fig. 50).

The streets of one parish met those of another almost accidentally when, in the process of land reclamation, the islands joined up. In consequence, though the principal thoroughfares were linked by bridges over the canals, the other streets did not fit together so easily. It is still possible in a map of modern Venice to detect discord in the street patterns at parish boundaries. At the edges of the parishes, bridges often cross the canals at an angle because the streets are out of alignment, or come to a dead end on a canal bank. Because of the absence of fast, wheeled traffic, there was little need to eliminate kinks in the street network. The pedestrian could easily scuttle round corners that a horse-drawn coach could not possibly have negotiated. Some of the streets of Venice are less than one metre wide. In Goethe's words: 'As a rule one can measure the width of an alley with one's outstretched arms; in the narrowest one even scrapes one's elbows if one holds them akimbo.' Other medieval cities had their share of higgledy-piggledy, narrow, winding streets, but few such labyrinths have survived on a large scale because of the danger of fire and the problems of traffic congestion and overcrowding.

All these difficulties struck Venice, too, but it was harder to eliminate them. Fires were an ever-present hazard in the city, and because of the closely spaced buildings they spread rapidly, especially in windy conditions. Venice was to some extent fortunate, in that most parts of the city had nearby canals to supply water for fire fighting, but this did not prevent numerous, terrible conflagrations. Possibly the most traumatic of all was the fire that devastated virtually the whole of the island of Rialto in 1514, but the chronicles and histories of Venice record many other major fire disasters.

Traffic congestion on both streets and canals was a perpetual worry, and was controlled by strict government legislation. Special magistracies were responsible for keeping the streets and canals free of obstruction. All private individuals had to apply to these magistracies for planning permission to build in the city. Careful measurements were then...
Overcrowding was a problem that Venice could do little to remedy, for there was not much scope for expansion on the margins of the city. Whereas in a mainland city such as Florence a series of new walls enclosed progressively larger areas as the city grew, Venice could only grow by the painful process of draining land from the lagoon (fig. 4). The shortage of land was most acute in the quarters around the Rialto and Piazza San Marco. The demand for property in these central zones made the price of land tremendously high. Sites on the Grand Canal, which had the advantage of prestige as well as a fine view, were also much sought after. The high land values led to certain characteristic features in the city’s architecture. A house owner could more cheaply extend his accommodation by adding an extra storey on top of his own building than by acquiring a neighbouring site. One can often see the various floors of a palace built in progressively later styles towards the top – conspicuous examples include the Ca’ da Mosto and the Palazzo Priuli-Bon at San Stae (figs 25 and 56). As Goethe put it: ‘The houses grew upward like closely planted trees, and were forced to make up in height what they were denied in width.’ The most extreme example of this process of upward growth can be seen in the former ghetto (called by the Venetian word for iron foundry, since there was once a foundry on the site) where all Jewish residents were forced to live from 1516 (fig. 35). A house owner could also enlarge his living accommodation by building out his house over a public street, so that the street passed through
a short arcade known as a *sottoportego* (fig. 106). Except in Piazza San Marco and the Rialto market, continuous shopping arcades like those of mainland cities such as Padua and Bologna are not found in Venice, where the streets are too narrow, but these space-saving *sottoporte* are very common.

Another means of expanding the interior space in a dwelling was to project the upper storeys a short distance over the street, supported on wooden jetties or stone corbels. One of the most interesting examples is the street picturesquely named the Calle del Paradiso, adjoining the Salizzada San Lio (fig. 34). The narrow street is flanked by shops and workshops on each side, with staircases leading to the living apartments above, a layout typical of Venetian small-scale property developments. The upper floors project on either side almost to within arm’s reach of each other. At each end of the street they are joined by decorative Gothic arches – a device commonly used in Venice to indicate property ownership. The arch at the canal end is decorated with a relief of the *Madonna della Misericordia* and dated 1407, but the buildings themselves have probably been replaced in piecemeal fashion, for the dates of the various parts range from the thirteenth to the sixteenth centuries.

Despite the serious shortage of land, there are open spaces in Venice. Francesco Sansovino claimed that all the parish *campi* placed side by side
side would make an area large enough for the site of a whole city. There have always been plenty of private gardens, even in the more central parts of Venice. The visitor on foot is hardly aware of the gardens, concealed behind high walls; but when seen from the top of the campanile of San Marco, the city does not in fact lack greenery. Sansovino mentioned all the most famous gardens in his guidebook in 1581, admiring their fountains, rare plants, sculpture and even paintings. According to de’ Barbari’s map of 1500, the island of Giudecca was then occupied by pleasant suburban villas with extensive gardens (fig. 35). At that time expansive gardens, orchards and vineyards occupied the peripheral quarters, now mostly built up. Just as any walled city in the later Middle Ages included cultivated areas, chiefly market gardens, inside the fortifications, so Venice had semi-rural areas within the boundaries of the city, to provide fresh fruit, vegetables and dairy produce.

Before the twentieth-century wave of emigration, with large numbers of the inhabitants moving to the neighbouring mainland town of Mestre, the population pressure in Venice was alleviated only by natural causes, in the form of high mortality rates and outbreaks of plague. Epidemics spread easily in the overcrowded conditions, especially since no one realized that bubonic plague was carried by rats, and typhus by lice. By far the most terrible pestilence was the Black Death, which killed 50 or
60 per cent of the population of the city between 1347 and 1349. A series of lesser epidemics struck the city at intervals during the next two centuries, but these did not have a significant effect on the population. For instance, after the severe famine of 1527, serious outbreaks of typhus and bubonic plague occurred, but so many of the victims were starving peasants from the mainland, who had migrated to Venice in search of food, that the resident population was reduced by only about 4 per cent. During the sixteenth century the population rose rapidly, to reach its all-time peak of 190,000 before the next great plague of 1555–7, when one-third of the inhabitants of Venice perished. Another outbreak of similar magnitude occurred in 1630–31. On each occasion there was a rapid, partial recovery in population, as immigrants from the mainland flocked into the city to take up the vacant jobs. In general the population of Venice since about 1300 has remained remarkably stable, fluctuating between about 100,000 and 140,000 for most of this period. The figures refer to the city itself, which has no sprawling suburbs on account of its restricted site. This fact obviously distinguishes Venice from other important European cities; but we must not forget that the city did develop its own suburbs on the nearby mainland and on the Lido.

**Building Materials and Techniques**

Venice is founded on sand, silt and clay, topped by gravel in the higher spots such as Piazza San Marco and the Rialto. Most visitors think of Venice as flat, but anyone who lives in the city for some time soon learns that there are minor variations in elevation, for the lower parts are more likely to be flooded in the high tides. In reality Piazza San Marco is no longer one of the highest points; its level has sunk, not only because of the subsidence resulting from the removal of artesian water from the bedrock of the lagoon, which has affected the whole city, but also on account of the great weight of buildings around the Piazza, which has compressed the subsoil over the centuries. In the streets, the paving stones are laid directly on to the sand, as one can clearly see when repairs are carried out. Before the fifteenth century few streets were even paved—they were merely paths of beaten earth.

Buildings naturally need a more elaborate substructure than the paving of streets. In the first areas to be settled, the ground was firm enough to proceed without special foundations. In these parts, elder stakes about one metre long supported a horizontal platform (known as a *zatterone* or large raft) of elm and larch and foundation walls of large stone blocks. Elsewhere the foundations depended on the firmness of the subsoil and the weight of the building to be erected. The main principle of Venetian building construction is that the buildings, in effect, were designed to ‘float’ on the wet sand and mud, in order to resist the constant movement caused by the tides. Because of the high cost of oak timbers, pile foundations were used only when strictly necessary: for example on the edges of canals, beneath heavy or tall structures, or on exceptionally soft terrain. It is important to remember that the piles did not reach solid rock, but served to stabilize structures in the soft lagoon mud. Every substantial building on a poorly consolidated site had to be supported on oak piles, driven deep into the alluvial clay by teams of labourers with heavy hammers, cheered on by rhythmic beating songs. These piles were at least three metres long. Most were sunk underneath the structural walls of a building, those that had to carry the greatest load. Interior dividing walls had less substantial foundations, a fact that has led to subsidence in many cases. Like the wooden *zatteroni*, the piles remain constantly wet, allowing them to resist decay over centuries. Indeed, pile foundations can be reused over and over again, a factor that has contributed to the enduring character of Venetian plan-forms.

Preparation of the site for building was an elaborate procedure. Clay was excavated from within the solid line of piles marking the perimeter walls. Along the edge of a canal a stockade of piles lined with wooden planks served to keep water out of the foundations during building, and a moat was dug around the edge before the site was drained. If necessary, more piles were sunk beneath the structural walls, and sometimes in the central space as well, and the ground was built up with layers of crushed brick and stone and larch rafts set in lime mortar. The tops of the piles were smoothed off about three metres below the high-tide level, to serve as a base for the *zatterone*, formed of two layers of larch planks, each arranged at right angles to the one below, that helped to spread the weight on the soft ground. Buildings were liable to subsidence if loads were unevenly distributed on the *zatterone*, because of the continual movement of the tides through the subsoil. The foundation walls were built very wide at their base, narrowing gradually towards the high-tide level. Horizontal layers of impermeable Istrian stone in the foundations discouraged rising damp. If the whole base wall was not built of Istrian stone, it would be faced with a layer of the white stone on the outside, and lined with clay on the inside.

Brick was the most common building material in Venetian architecture, for it was economical, lightweight and permeable (allowing moisture to dry out). The bricks made of clay from the nearby mainland have a rich red-brown colour, which gives a characteristic element of warmth to the townscape. Terracotta roof tiles came from the same source. In the brick walls the pointing was composed of traditional lime mortar, flexible enough to allow a degree of movement on the unstable foundations.
Many of the brick walls that are now exposed were once completely covered with a thin layer of stucco. The typical Venetian stucco was *cocciopesto*, made of ground terracotta tiles in a bed of slaked lime and water, producing a warm red colour like that of the brickwork. A more glistening finish could be obtained from the use of *marmorino*, a stucco of a similar composition but with the addition of granules of Istrian stone without any sand. Examples are still visible, though modern stucco work is coloured artificially. Some of the stuccoed walls were covered with a light grey plaster and then frescoed, but the wall-paintings soon perished in the humid, saline atmosphere. Fragments of frescoed figures by Giorgione and Titian, rescued from the Fondaco dei Tedeschi, can be seen in the Ca' d'Oro and the Accademia.

There is no local stone in the immediate vicinity of the lagoon. The soft yellowish limestone quarried near Padua, like the sandstone of Vicenza, weathers so easily that it could not be used in Venice. The building stone most widely used in the city was the brilliant white, marble-like limestone from Istria, which could be cheaply transported from the quarries by sea. Though hard, Istrian stone is easy to carve because of its fine, even grain. Yet, being virtually impervious, it is remarkably resistant to weathering, even in the humid, saline and now badly polluted atmosphere of Venice. Canaletto’s evocative painting in the National Gallery, London, known as *The Stonemason’s Yard*, shows stonemasons preparing huge blocks of Istrian stone for the new façade of the nearby church of San Vidal (fig. 36). Details such as window frames, capitals and bases, cornices, gutters, steps, balustrades and doorways are generally of Istrian stone. As mentioned, the use of the same stone up to the high-water mark of a building helped to impede rising damp in the walls. (Unfortunately, as a result of subsidence, these damp courses are no longer effective.) From the Renaissance onwards, the grander buildings were faced entirely in Istrian stone, concealing the brick walls beneath.

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In the more expensive buildings, red marble from Verona was imported for carved details such as portals and fireplaces. This stone...
has a glowing rust-red colour when polished, although it weathers to a rougher, pale pink surface. The weathering process is well demonstrated by the two red marble lions in the Piazzetta dei Leoncini behind San Marco, whose backs are polished to a shiny red by many generations of Venetian children riding them, while the rest of their bodies have turned a dull pink. The restoration of the Loggetta at the foot of the campanile of San Marco in the 1970s revived the red polished surface of the Verona marble, which had faded through the same weathering effect (fig. 104). Unfortunately, since then, the silicon resin applied to seal the newly cleaned stone has turned milky and dulled the rich red colour. A checked pattern of red marble from Verona or Cattaro and white Istrian stone was popular for the paving of ground-floor rooms such as androni and church naves.

Other precious marbles added to the prestige value of a building. As we have seen, San Marco is adorned with rare oriental marbles, many of them looted from Constantinople (fig. 16). The façade of the Palazzo Vendramin-Calergi (now the winter Casinò), built at the beginning of the sixteenth century, incorporates porphyry, serpentine and veined oriental marble (fig. 82). The cleaning and restoration of the façade of the Scuola Grande di San Rocco in the 1990s revealed a stunning profusion of rare, costly marbles. As well as the red Verona marble just mentioned, the Loggetta, built by Jacopo Sansovino from 1538 to 1545, has carved details of white Carrara marble, Istrian stone and the dark-green stone known as verde antico, while the columns are of various rare oriental marbles (fig. 104). The same architect, sent to restore the church at Pola (now Pula) in Istria, removed the priceless marble columns for use in his own buildings, chiefly the Library. He replaced them by brick piers, but within a decade the ‘restored’ church at Pola was a total ruin.) One of the most remarkable instances of the ostentatious use of costly materials was the Ca’ d’Oro, built by Marino Contarini in the early fifteenth century (fig. 59). As we shall see, the building accounts show that the façade was not only decorated with precious marbles, but was once also painted in ultramarine (the most expensive colour pigment of all, made from ground lapis lazuli) and gold.

Wood was the indispensable raw material for the Venetian building industry. It was needed not only for piles but also for ceiling timbers and roof beams. Dalmatian oak, imported by sea, was the most resilient wood for piles, though it was restricted in length. Oak supplies were also floated by river to Venice from Friuli and from the area around Treviso (fig. 4). By the early thirteenth century coniferous wood, chiefly larch or fir, was already being floated down to Venice along the rivers from the forests of Cadore in the Dolomites. This softer type of wood was especially useful for ceiling beams, not only because of the length of the timbers but also on account of their light weight, elasticity and high
resin content to resist damp. The usual length for wooden joists varied
between 5 and 6.5 metres; this determined the standard spacing of struc-
tural walls, thus giving a remarkably consistent grain to the city. On the
unstable Venetian soil the greatest possible flexibility was needed in a
building to absorb minor shifts in the foundations. For this reason,
vaulted ceilings are rarely found in Venice, except in churches where they
are usually supported by wooden tie beams.

Ceiling beams were closely spaced to spread the load more evenly, and
nailed to a horizontal wooden beam set into the inner face of the wall.
In addition, at regular intervals, iron tie rods secured to blocks of Istrian
stone in the outside of the wall could be fixed to the joists. Such blocks
of stone still visible in the façade brickwork indicate the position of the
internal floors. The joists were topped by two layers of wooden planks,
arranged at right angles to each other - the so-called Sansovino ceiling.
The visible timbers were often richly decorated with painted or carved
designs. With the huge demand for wood - especially oak - for the
Venetian shipbuilding industry, the mainland forests were becoming
badly depleted by the end of the fifteenth century. As a result the price
of wood rose sharply, but there was no possible substitute in the build-
ing trade. The foundations alone might cost as much as a third of the
total cost of a building. Building accounts preserved from the restora-
tion and extension of Ca' Giustinian in the 1470s show that wood
accounted for 43 per cent of the total cost of materials.

Wood was also needed for roof construction. As Francesco Sansovino
remarked, "The roofs of the [private] buildings are usually hipped [in
quattro acque]. His wording reminds us of the important function of
the roof as a catchment area for rainwater, which had to be collected in
a continuous Istrian stone gutter around the roofline. Like the ceilings,
roof timbers were of larch or pine. The rafters were closely spaced and
overlaid with thinner purlins, above which a layer of flat tiles formed a
base for the characteristic curved tiles, semicircular in section, on the
top. In all larger buildings a truss system had to be adopted to span
the whole roof, either by placing the trusses over the internal partition
walls, or using the so-called Palladian truss, from which the ceiling below
could be suspended with iron straps.

The need for flexibility also fostered the development in Venice of
special types of flooring. In the simplest houses, the floors were merely
bare wooden boards or sometimes brick tiles, with beaten earth in the
ground-floor rooms. A more elegant surface, known as pastellon, was
composed of ground tiles and bricks set in lime mortar and polished to
bring out the red terracotta colour, which was intensified by the addi-
tion of the pigment cinnabar in the top layer. From the fifteenth century
onwards, pastellon was largely superseded by a more decorative version
called terrazzo. In living apartments this surface, like pastellon, was
laid on top of the boards covering the ceiling of the floor below. It was made up of two layers of crushed brick and stone set in lime mortar, each layer well beaten down with battering rams for several days. Several months had to elapse between the laying of the two layers. The top layer also contained chips of coloured marble, so that when it was smoothed off with mill stones and oiled with linseed oil the effect was like a random mosaic. As in the case of pastellon, the lime base and tiny stones gave a certain elasticity to the floor surface, so that it could resist minor stresses and strains without cracking. If cracks did appear, it was a fairly simple matter to lay another thin layer of terrazzo on top. According to Francesco Sansovino, terrazzo floors were so highly polished that one could see one's own reflection in them, and carpets were even put down to prevent footprints marking the floors.47

The other Venetian building practice that greatly impressed foreigners was the extensive use of glass in the windows.48 The glass industry on the island of Murano, and even Venice itself, was flourishing by the end of the twelfth century. Glass furnaces were finally banned from Venice in 1291 because of the risk of fire, and the industry became concentrated in Murano.49 Francesco Sansovino, writing in 1581, claimed that even the humblest buildings in Venice at that time had glass windows, whereas other cities had to make do with oiled canvas or parchment.50 The round discs of clear bottle glass were held in place by lead and iron, in wooden window frames, as one can clearly see in Carpaccio's painting of the Dream of Saint Ursula in the Accademia (fig. 38). (This picture gives a vivid impression of a Venetian bedroom in the late fifteenth century.) Some bottle-glass windows still exist in Venice, though most have been replaced by plate glass. As we have seen, Venetian buildings needed the largest possible windows to admit light in the cramped surroundings, but without the local supply of glass large windows would have been unthinkable in the Venetian climate.

Iron was not used very extensively in Venice, for it tends to corrode in the damp climate, but small quantities of iron were needed in every building for door locks, window fittings, hinges, railings and other such details.51 The usefulness of iron to secure floor joists and to suspend ceilings from trusses has already been mentioned. From the nineteenth century onwards it became common practice to secure leaning structures with iron tie beams. Earlier, iron chains had been used for the same purpose. Neither method proved very satisfactory in the long run, since iron is too rigid to accommodate minor movements in the structure. Buildings restored in this way have tended to develop serious cracks in the stone blocks in which the iron was fixed. Furthermore, the effect of the iron rusting where it comes in contact with the atmosphere has caused corrosion in the walls around the points of insertion of the tie rods or chains.
Each building technique was carried out by specialist craftsmen belonging to separate artisans’ guilds. There were bricklayers, stone-masons, terrazzieri, carpenters, glaziers and smiths. These craftsmen had to serve an apprenticeship of five to seven years, usually starting at between 12 and 15 years of age, followed by a period of two or three years as assistant to a guild member. At the end of the training they had to take a test to prove their competence, before they were admitted as
capomaestri or master craftsmen. Sons of guild members, if apprenticed to their fathers, were exempted from the final examination. The successful candidates in the terrazzo-makers’ test, which involved making a floor of eight Venetian square passi (paces), not only had to pay a fee but also had to invite the examiners to dinner. The labourers who assisted the maestri were not guild members, except in the stonemasons’ yards, but were casual employees paid by the day. Each workshop had one capomaestro, who employed two or three assistants in addition to his own sons and his apprentices. The patrons, or groups of individuals, wishing to erect a building usually did their own subcontracting. They invited estimates from various craftsmen for each job, and awarded the contracts to the maestri offering the most favourable terms. Only the stonemasons supplied their own raw materials, for they had to choose the most suitable stone for each job. Otherwise a patron had to arrange separate contracts with the suppliers of bricks, lime, sand, wood and iron, as well as with boatmen to transport heavy cargoes, such as mud excavated from the canals or rubble for the foundations. By this system each artisan needed very little capital. He merely had to own or rent a workshop and provide his own tools. And indeed he had little opportunity to accumulate capital. Both the practice of subcontracting by the patron, which prevented the growth of larger scale firms of all-round building contractors, and the statutes of the individual guilds discouraged the acquisition of wealth or power by a single craftsman. The skilled artisan was a respected member of Venetian society, but he was kept firmly in his place.

As elsewhere in medieval Europe the designers of buildings, like other artists, were rarely named or recorded in documents, and few of their works of art were signed. It should not, however, be assumed that in the Middle Ages buildings grew almost organically, fed by a kind of communal urge to build. Most architectural designs were probably the product of close collaboration between the patron and the chief artisan, usually a stonemason, and it is the identities of the patrons rather than the architects that have survived to posterity. Before the Renaissance, when the value of creative genius at last began to command as much respect as the wealth and enterprise of the patron, it is rarely possible to identify the artistic personalities of individual architects. The fact that the title architectus was not used in Venice until as late as the 1470s, apart from one known isolated example in 1455, is symbolic of the change in attitude that came about at this time. 
Essential Services and Other Amenities

The peculiar physical environment of Venice, the building techniques adopted and the particular functions of the buildings have all contributed to the special character of Venetian architecture. The provision of essential commodities such as heat, light, water supply and sewage disposal also led to solutions that have left their imprint on the urban landscape. Certain distinguishing features are immediately obvious to the visitor, others are less easily recognized, but all show a high degree of adaptation to the surroundings.

Every dwelling in the city needed efficient heating. Venetian winters can be bitterly cold, especially when the piercing wind called the bora blows from the north-east. Snow is not uncommon, though it rarely lies for long because of the proximity of the Adriatic sea. The most famous frost was probably that of 1788, recorded in an anonymous painting in the Museo del Settecento at Ca' Rezzonico. But in spite of the fact that the temperature rarely falls far below freezing point, the constant dampness gives a raw chill to the winter air.

Renaissance portraits show that it was fashionable for those who could afford it to dress in furs and heavy velvet cloaks - and with reason. As late as 1849, in a letter of 3 December, Effie Ruskin complained of the cold in Venetian palaces:

... We went today and looked over several Palaces but although the outsides are splendid Venetian Gothic I cannot fancy how the Italians live, for the insides although perfectly clean have such a want of comfort about them ... and no fire places, even in this cold weather. Each member of the family carries about on their arm an earthen basket or pot with hot charcoal in it ... The tessellated floors, although very smooth and glittering, are extremely cold and all their arrangements seem made for heat and not cold.\textsuperscript{55}

The great central halls, or porteghi, of Venetian palaces were usually unheated, and with their huge expanses of window at either end they must have been extremely draughty. We read in Francesco Sansovino's guide of 1581 that:

All the bedrooms have fireplaces, but not the living-rooms. This is certainly wise, because when one gets out of bed, the fire is nearby, not only to dry the humidity which one gathers around oneself when sleeping, but also to heat the rooms and to purge the evil vapours which rise from the air or other sources.\textsuperscript{56}

Sansovino also believed that centuries of burning fires had in some way purified the unhealthy air that the first settlers encountered in Venice.\textsuperscript{57}
Fireplaces were usually on the outside walls, arranged one above the other, their flues connected to the same chimney. The disposition of windows in pairs, with a space between, commonly seen on the exteriors of buildings such as the façade of the Fondaco dei Tedeschi, indicates a sequence of rooms in the living apartments inside, each with one window on either side of the fireplace. In the more modest buildings the chimneys often projected outwards from the side of the building, in order to save valuable space in the interior.\textsuperscript{58} The smaller dwellings were obviously easier to heat than the great palaces, so that the poorer people could at least survive without fine furs and rich materials.

The distinctive chimney pots, which appear in views of Venice from Carpaccio to Canaletto, and a few of which still survive today, were one of the most curious features of the Venetian townscape (figs 28 and 36). Of unusually large size, they were generally in the form of truncated, upturned cones, although there were many other variations. It is revealing that this was also the characteristic shape of the funnels of early American wood-burning steam trains, wood being the fuel normally used in Venice. The main function of the chimney pots was to prevent sparks from escaping from the flues, for the risk of fire in the city was always a problem. They served not only as cinder traps, but also, of course, to keep out the rain and perhaps to improve the drawing power of the fires by impeding down draughts in the chimneys. The Venetians evidently took pride in embellishing these conspicuous terracotta chimney pots with painted or relief decoration, as one can see, for example, on the left side of Carpaccio’s painting of the \textit{Miracle of the True Cross} (fig. 28).

The small enclosed courtyards that punctuate the dense urban fabric of Venice were important for the provision of both natural light and fresh water. Some were private courts inside palaces, usually placed at the back or on one side; others gave access to a number of more humble houses, generally the property of a single landlord. Until the sixteenth century, staircases were generally accommodated in the courtyards, to save space inside the buildings. The poorer dwellings had simple wooden ramps, while palaces were provided with elaborate stone staircases with carved balustrades, some originally roofed with wooden canopies. The most flamboyant external stairway in the city is the splendid spiral staircase known as the Scala del Bovolo (\textit{bovolo} is the Venetian dialect word for a snail shell), built for a branch of the Contarini family around 1499 (fig. 26).

The provision of an adequate supply of fresh water has always raised problems in Venice, for the canal water is saline and polluted by the discharge from the city’s drains. Because the rain normally provided all the drinking water, elaborate provisions were made for its collection and storage. Public wells in the parish \textit{campi} were fed by rainwater collected in underground cisterns. These yielded enough water except in times of
drought, when fresh water was brought from the mainland in barges. The occupants of private palaces relied on rainwater collected from the rooftop in Istrian-stone gutters, and funnelled through glass or terracotta drainpipes within the walls to the well in the courtyard (fig. 39). There it was filtered through sand, and stored in a cistern beneath the courtyard. Cisterns were clay-lined, usually about 3.5 metres deep, and filled with sand for filtration purposes. Water falling on to the paving of the courtyard itself was collected through a series of drains into a small terracotta underground gallery just below the surface, from which it seeped into the cistern below. Empty cisterns could be replenished with fresh water imported by boat. Until the mid-fifteenth century, all cisterns were located in the open air, either in public campi or in private courtyards or even monastery cloisters. From the sixteenth century onwards it became popular to construct cisterns beneath the interior of the house. As late as the nineteenth century, there were still 6,782 functioning cisterns in the city.
The fine Istrian-stone or Verona-marble well heads, called *vere da pozzo*, are a notable component of the Venetian scene. A number of them are extremely ancient, to judge by their Byzantine-style carved decoration. It is typical of Venetian visual sensibilities that such a basic functional necessity should have become the excuse for decorative expression and the display of family coats of arms. In the Gothic period many were give the form of huge Corinthian capitals, reminiscent of the fragments that still litter antique cities such as Rome and Constantinople.

Sewage disposal was less of a problem in Venice than the water supply, for the ebb and flow of the tides removed the effluent with great efficacy. Even today the city relies on natural drainage. Unfortunately, however, in recent decades, pollution of the lagoon by agriculture, industry and domestic cleaning products has disturbed the natural decomposition of organic waste. The problem of ecological imbalance is exacerbated by insufficient dredging of the canals. Until the twentieth century the drains discharged their effluent at mid-tide level, so that the outlets were actually exposed at low tide, but now they are out of sight. Houses with no direct access to a canal were connected with covered drains leading to the nearest waterway. Only those houses that were furthest from the canals had to be content with cesspits. In this respect Venice had a great advantage over mainland cities – at least until the era of mains drainage. Human manure was shipped to the market gardens of the lagoon for use as night soil. Solid refuse, collected in boats, was carried to dumps on the mainland, or used to build up land for reclamation. In the mid-sixteenth century there were complaints that mud, rubble and other rubbish supposed to be deposited at Marghera were being dumped in the lagoon, because the boatmen did not take the trouble to complete the long journey.  

Finally we should mention the profusion of balconies on Venetian buildings, and the curious terraces, called *altane*, on many of the rooftops. Balconies at *piano-nobile* windows were not unknown in the grander town palaces in other parts of Italy, especially after they were introduced by Bramante in his famous House of Raphael in Rome in the early sixteenth century. Open *logge* under the huge overhanging eaves of Florentine palaces served a similar purpose (though in the hotter summers of Florence shade was preferred to sun). But in Venice, because of the shortage of space for gardens and the poor light inside the buildings in congested areas, balconies are far more numerous than elsewhere, especially where the windows offer expansive views of the city.

Early examples took the form of simple Istrian-stone ledges supported on stone brackets and provided with plain iron railings for safety. Frequently the balconies are not coeval with the houses, having been added or replaced at a later date. Very broadly, one can date Venetian balconies (though not the buildings behind) to within a hundred years.
or so by the form of the balustrade. The typical quattrocento baluster was a slender classical colonnette, while the stone handrails often had seated lions or small stone busts at the corners. In the sixteenth century Sansovino introduced a new type of baluster borrowed from Michelangelo in Florence, which became extremely popular (figs 102 and 107). This was broadest in the middle, with a cubic block at the centre. At the same period Sanmicheli also used balusters that were broader in the middle, but with a 'waist' at the centre (fig. 108). In the seventeenth century a more baroque type of baluster, broader at the bottom, was adopted, sometimes alternating with uprights broader at the top, as in Longhena's Ca' Pesaro (fig. 130). The eighteenth century's rococo taste favoured little curved balconies with wrought-iron railings (fig. 56). Naturally this generalized outline does not accommodate all possible forms of balustrade, for the Venetian decorative imagination ranged far and wide, as we can see in the marvellous balconies of the Palazzo Contarini-Fasan (traditionally known as the house of Desdemona) which are like petrified Burano lace (fig. 62).

The rooftop altane take the form of wooden platforms supported on brick piers and reached by a dormer window. A good example appears on the skyline of Carpaccio's Miracle of the True Cross (fig. 40).
Vittore Carpaccio, *Two Venetian Ladies*, c.1495 (Museo Correr, Venice). Now known to be the lower part of the panel known as *Hunting in the Lagoon* in the Getty Museum in Los Angeles, this painting shows two noble ladies amusing themselves on a rooftop *altana* or balcony.
altana was used for drying washing, beating carpets and taking the sun. We must not forget that Venetian noble ladies were strictly chaperoned, and were only allowed out in the streets veiled and accompanied by their maids. Instead, they spent much of their time on the altana, bleaching their hair to the fashionable Titian-blonde colour. For this purpose they wore special straw hats without crowns, draping their long hair – anointed with a special preparation called acqua di gioventù – over the broad brims. Carpaccio’s enigmatic painting in the Museo Correr, long misleadingly known as The Courtesans, shows two noble ladies idling away their time on balcony or altana, with the help of a child, two dogs, a peacock and some other tame birds (fig. 41). It is now known that Carpaccio’s painting of Hunting in the Lagoon, now in the Getty Museum in Los Angeles, originally formed the upper part of this picture. Thus, from the confines of domesticity, the ladies could gaze on their menfolk enjoying the freedom of the natural world. In the corner of the Museo Correr picture one can see the absurdly high platform-soled shoes that restricted their movements yet further, for they could hardly walk unsupported. Coryate saw a lady fall on a stone bridge in her platform shoes, ‘but I did nothing pity her, because shee wore such frivolous and (as I may truely terme them) ridiculous instrumenrs’.

Although a number of examples have been drawn from later periods, it should be remembered that as early as the beginning of the fourteenth century the city of Venice had already acquired many of the characteristics outlined in this chapter. By that time, a range of building types had evolved to suit the particular needs of the city. These were to change only superficially for the rest of the duration of the Venetian Republic, which ended in 1797. Stylistic changes affected little more than the decorative language, both inside and out. The rest of the book will deal chiefly with these transformations, which were guided partly by changes in taste throughout Europe, partly by the personalities of the greatest architects who worked in the city, and partly by internal developments within Venetian society itself.