GUIDE TO THE WORKS EXHIBITED

ENGLISH

WATER
EARTH
FIRE

INDUSTRIAL
ARCHITECTURE
OF THE
RENAISSANCE
IN THE VENETO

PALLADIO
MUSEUM

Palladio lived through a remarkable period of innovation in the Veneto, not only in architecture but in every sector of the economy. Recent historical research has highlighted the involvement of many of Palladio's patrons in the silk trade, but this exhibition presents to the public an even richer creative context. There were not only flour-mills and silk-mills, but also woollen mills, sawmills, forges, foundries, lime-kilns, leather tanneries, mines, and mills for crushing stones.

At the same time, in the second half of the sixteenth century the number of patent applications for new mechanical inventions submitted to the Venetian Senate increased dramatically. The inventors came not only from the Veneto but also from elsewhere in Italy and other European countries, to make the Venetian Republic a hub of international exchange in new technologies.

In particular these entrepreneurs took advantage of the new spirit of innovation to expand the use of water power. The existence of a line of natural springs across the foothills of the Alps between Brescia and Udine provided the ideal context for new industrial mills, because spring-fed waterways remained constant all year round in both temperature and volume.

This exhibition traces the expansion into the countryside of a range of industries previously powered by men or animals and mainly confined to the cities. The beautiful sites examined in the course of our research will be exhibited through artefacts of the period, films, paintings, drawings, maps, early printed books and manuscripts, all displayed within a lively, engaging design setting.

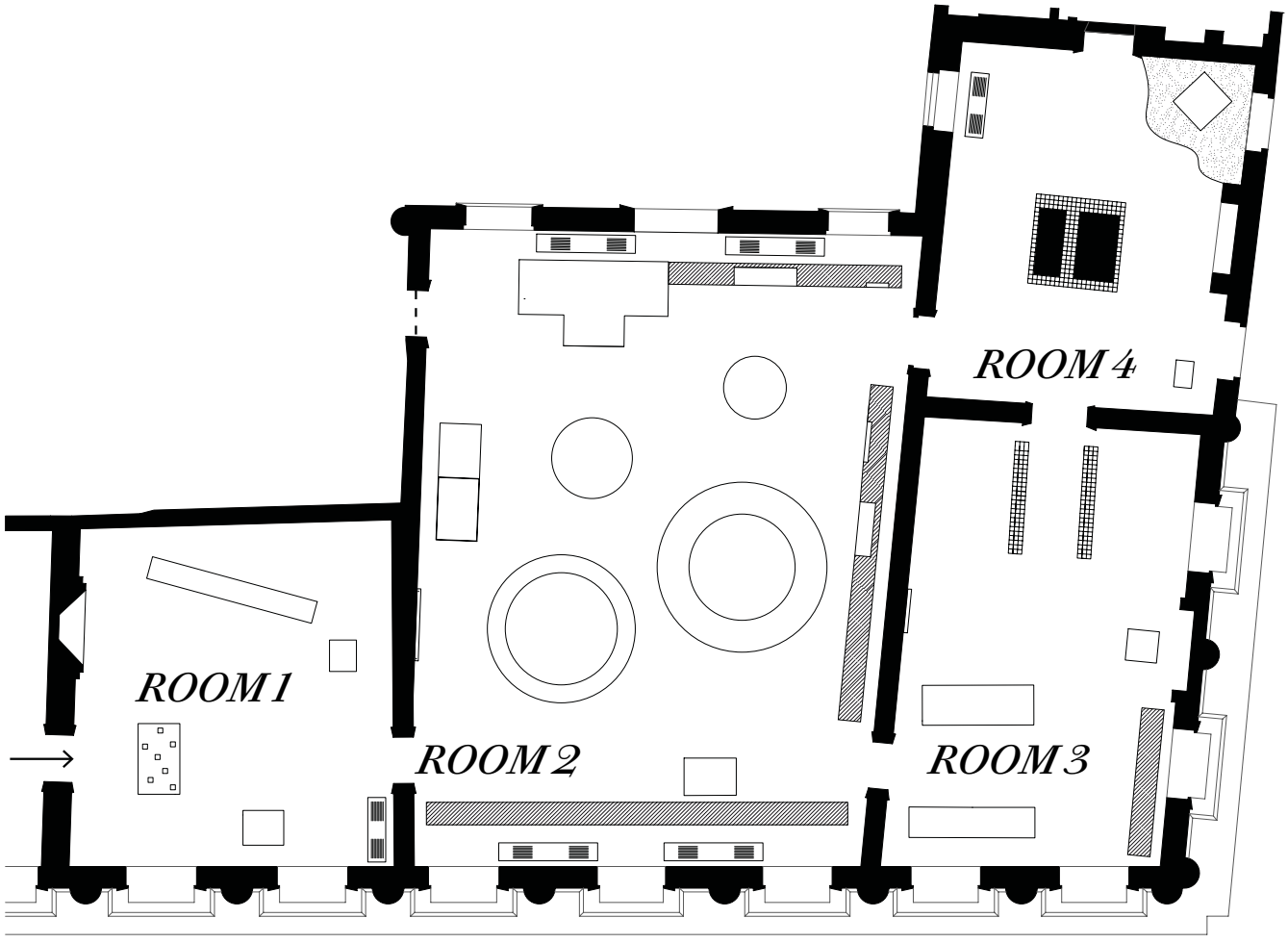
The exhibition will allow us to reassess in our own time:

- The importance of the proto-industrial heritage of the region;
- The use of economical and traditional building materials;
- The potential of renewable, clean energy;
- The role of the Veneto as a centre of commercial innovation.

Download the audio guide to listen to the curator of the exhibition, Deborah Howard, on your mobile.

Deborah Howard
22 September 2022

EXHIBITION PLAN



ROOM I

The natural springs north of Vicenza
2022
video by Fausto Caliari and Davide Provolo
drone operator: Daniele Pernigo

In the Veneto of the Renaissance, natural springs like this could feed streams and artificial channels to drive the wheels of many kinds of mills. The increasing exploitation of spring-fed water-courses in the 16th century led to a steady expansion of proto-industrial enterprises in rural areas, to complement the existing manufacturing activity of the cities.

BOOKS OF INVENTIONS

1

Anonymous, after Francesco di Giorgio Martini
Raccolta o Album di disegni d'architettura e d'ornato
16th century
Padua, Biblioteca Universitaria, Ms. 764

Images of mechanical inventions circulated in the Veneto in both manuscript and print. This set of pen drawings on paper, numbering 127 sheets in at least two different hands, seems to be a collection drawn from various sources, including images derived from the Sienese military engineer and architect Francesco di Giorgio (1439-1501), as well as other material such as antiquities.
In *c.* 1477 Francesco di Giorgio had presented his *Opusculum di architettura* to his patron Federico da Montefeltro, duke of Urbino; this master set of drawings on vellum, depicting machinery and fortifications, is now in the British Museum, London. Copied and recopied during the late 15th and 16th centuries in Italy, these drawings circulated widely, and were certainly known by Leonardo among many others.

2

Giuseppe Ceredi
Tre discorsi sopra il modo d'alzar acque da' luoghi bassi
Parma 1567
Vicenza, Biblioteca del CISA Andrea Palladio, F.A. II 37

Ceredi mentions that Palladio showed him a most excellent, unpublished spiral mechanism for raising water, and adds that Palladio's patron Marcantonio Barbaro had already praised the invention. The machine he illustrates is a kind of Archimedes screw, similar to a device mentioned by Vitruvius in his *Ten Books on Architecture*. Most of the hydraulic technologies in use in the Veneto in Palladio's time had their origins in antiquity, but continual refinements in the 16th century improved their efficiency and reliability.

3

Agostino Ramelli
Le diverse et artificiose machine
Paris 1588
Vicenza, Biblioteca civica Bertoliana, F 34.5.18
The restoration of this book has been made possible by the association Amici della Bertoliana

Agostino Ramelli (1531-1600) was a military engineer born near Lake Lugano. In 1588, while in the service of the French king Henri III, he published this illustrated book of mechanical inventions from his own house in Paris. His book contains 195 engravings of machinery accompanied by explanatory texts in both French and Italian. The plate illustrated here shows an overshot water-mill for grinding flour. The mill is depicted in isometric projection, its machinery housed in an imaginary open wooden structure to allow all the moving parts, with their gears and cranks, to be clearly seen.

4

Johannes Stradanus (Jan van der Straet)
Nova reperta
Antwerp c. 1588
Rome, Biblioteca Angelica, C^.1.9

This remarkable set of nineteen engravings of new technologies, published in Antwerp, was designed in Florence by the Flemish artist Johannes Stradanus (1523-1605) in collaboration with his patron Luigi Alemanni. The mechanism of the flour-mills displayed here, with their lantern gears, is almost identical to that illustrated in Daniele Barbaro's translation of Vitruvius's treatise in 1556. The Latin inscription at the bottom underlines the continuity of hydraulic technology since antiquity. The double mill allows the parallel milling of wheat and maize, while floating mills are visible in the river on the right.

5

Fausto Veranzio (Faust Vrančić)
Machinae novae
Venice 1615
Venice, Biblioteca Nazionale Marciana, 213D 003

Faust Vrančić (1551-1617), known in Italy as Fausto Veranzio, was born in Šibenik and died in Venice. In his youth he followed a diplomatic career in the service of Emperor Rudolf II. In 1595 he obtained a *privilegio* (patent) from the Venetian Senate for the invention of various machines. His treatise, with its commentary in five languages, illustrates not only mechanical devices but also buildings, a scheme for three fountains in Piazza San Marco and a Leonardesque flying machine. Veranzio here illustrates the floating mills to be seen on faster-flowing rivers such as the Adige in Verona.

6

Vittorio Zonca
Novo teatro di machine et edifici per varie et sicure operationi
Padua 1621 (first ed. 1607).
Vicenza, Biblioteca civica Bertoliana, RN 8.i.21

Vittorio Zonca (1568-1603) was a municipal architect, surveyor and map-maker in Padua. His book of mechanical devices, first published posthumously in 1607, was so successful that it was re-issued several times. The engravings in his treatise reflect his first-hand knowledge of different types of manufacturing operations in the Veneto. This perspective view, seen from a high vantage-point, shows the operation of a water-powered cam-shaft to raise the pistons for crushing soaked linen rags, the first stage in the manufacture of paper.

PATENTS

7

Flour-mill, model
c. 1750
wood
Kunstsammlungen und Museen Augsburg, Maxmiliansmuseum, inv. no. 9701

When requesting patents (*privilegi*) from the Venetian Senate inventors often deposited working models of their innovatory devices in a secret room in the offices of the Provveditori di Comun. The viability and originality of their inventions would then be assessed before the *privilegio* was granted. The Republic's collection of working models has been lost, but the example displayed here, showing a flour-mill, survives in a similar collection in Augsburg, established in 1620 by architect Elias Holl.

Valle dei Mulini, Mossano (Vicenza)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

This village in the valley of the Scaranto preserves a chain of water-powered flour-mills. In 1544 an inventory recorded fourteen mills (several with two wheels), twelve of which survived into the 20th century. This proto-industrial complex is an excellent example of a quasi-modern system of production, whereby grain from the surrounding farmland was milled in bulk to supply flour to the cities.

Mulino Tessari, Grancona (Vicenza)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

Believed to date from the 15th century, this hydraulic flour-mill is fed by a *roggia* (mill-race) diverted from the River Liona. An overshot water-wheel (*a coppedello*), controlled by a small sluice gate, drives the two grinding mechanisms, one for wheat flour and one for polenta, set on an elevated wooden platform, exposing the gears underneath. The miller's residence occupies the same building, with a granary on the top floor. Most recently, four generations of the Tessari family have operated the mill.

LESSONS FOR THE FUTURE

8

Tomaso Fiorini (surveyor)
Small industrial complex on the Brenta at Solagna
26 February 1698 m.v. (1699)
pen and wash on paper
Archivio di Stato di Venezia, Provveditori ai beni inculti, Disegni, Treviso, rot. 423, mazzo 17, dis. 14

This drawing accompanied the request of Bernardin Renier for further water rights. The applicant planned to build a fulling-mill and a silk-spinning mill in the village of Solagna, using the same mill-race that already supplied the forge and the sawmill on his property, for which he had existing rights. This small mixed manufacturing complex lay on the left bank of the river Brenta to the north of Bassano.

ROOM 2: WATER

VICENZA

9 **10**

Giovanni Battista Pittoni
Bird's-eye view map of Vicenza
(the *"Pianta Angelica"*)
1580
pen and brown ink and blue water-colour on paper
Rome, Biblioteca Angelica, Banc. Stampe N.S.56/81

The "Pianta Angelica", model
2022
concept: Andrea Bernard
model maker: Riccardo Sivelli - Extralab
Vicenza, Palladio Museum

Sent to Rome from Vicenza early in 1580, this beautiful bird's-eye view was commissioned for a fresco in the Gallery of Geographical Maps in the Vatican Palaces. The use of blue wash for the city's rivers draws attention to the importance of these waterways for the production of textiles, as well as flour-milling. Water-wheels are visible around Ponte San Piero, Ponte Pusterla and Ponte San Michele. Near the Borgo Pusterla are *tiratoi* (racks for hanging textiles), while in a nearby orchard cloth could be suspended on nails in a covered drying area labelled *chiodara*.

VERONA AND MONTORIO

11

Bernardo Bellotto
View of Verona with the Castelvecchio and the Scaligero bridge across the Adige from upstream
c. 1745
oil on canvas
Collection of the Fondazione Cariverona, inv. no. 695

This canvas by Bernardo Bellotto (1721-1780) shows three floating mills, as well as a wooden barrier to protect the houses on the river bank, prior to the construction of the embankments after the great flood of 1882. The mills are connected to the banks by long narrow planks of wood, giving an impression of fragility, seen also in some early 20th-century photographs.

THE CITIES

12

Hydraulic structures at Montorio (Verona)
6 August 1577
pen and wash on paper
Archivio di Stato di Venezia, Provveditori ai beni inculti, Atti, b. 467, dis. 2

This map, made for Giulio Marioni in 1577, depicts a panorama of the district of Montorio with its network of waterways, several mills and the main buildings of the settlement. Among the features illustrated are the spring of the Squarà, the two main rivers (the Fiumicello and the Fibbio) and the numerous hydraulic interventions such as locks, sluices, ditches, *rogge* (mill-races) and small canals. This complex system of water-management provided an irrigation system and generated the kinetic energy needed to power flourmills, fulling-mills, forges and paper-mills.

Montorio (Verona)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

Known since Roman times, Montorio is now a division of the city of Verona, situated to the north-east in a zone endowed with numerous natural springs. These springs encouraged a dynamic and diversified manufacturing activity that depended on the availability of hydraulic power. The network of waterways, modified over the centuries and still visible today, consists of springs, natural streams, artificial canals and ditches. These are linked to the two main rivers, both of which rise in the centre of Montorio: the Fiumicello and the Fibbio. The first of these flows towards Verona, and the second to the nearby settlement of San Martino Buon Albergo before joining the Adige about 15 kilometres further downstream.

BASSANO DEL GRAPPA

13

Roberto Roberti
The Bridge at Bassano, with silk mills on the river Brenta
1807
oil on canvas
Bassano del Grappa, Musei Civici, inv. no. 74

Sited on the river Brenta between the mountains and the plains, Bassano's seasonally variable water supply was moderated by the construction of *rogge*, or artificial channels, to drive the hydraulic flour mills and to power textile production. After its annexation by the Venetian Republic in 1404, the city became a prominent wool manufacturing centre, and from the mid-16th century silk-spinning grew in importance. The water wheel on the jetty, visible in this view by Roberti, lifted river water into the raised channel that operated the silk mills *alla bolognese* in the tall buildings on the right.

PADUA AND TREVISO

14

Giacomo Alvise (surveyor)
Floating mills on the Ponte dei Molini in Padua
25 April 1767
pen and water-colour on paper
Archivio di Stato di Venezia, Savi ed esecutori alle acque, Disegni, Brenta, dis. 80

This map is preserved in the papers of the Venetian magistracy responsible for the control of the hydrographic regime of the vast hinterland of the Venetian lagoon. Moored to the bank or to the columns of a bridge, this type of water-mill, driven by a vertical wheel, was widespread in the plains of the Po valley because it was well-suited to water-courses with a constant flow. In Padua the floating mills were concentrated near the Ponte Molino, where they spanned the whole width of the river Bacchiglione, each one adapted to the depth.

15

Giovanni Maria Malimpensa
La origine della città de Trevisi
1546
Comune di Treviso, Biblioteca di Borgo Cavour
"Giovanni Comisso", Ms. 1398

Treviso lies at the junction of two rivers: the Sile flowing from the west around the southern edge, and the Botteniga which joins it from the north. Already in Roman times a sluice gate on the city's northern perimeter divided the flow of the Botteniga into separate channels to power the city's mills. After the Wars of the League of Cambrai (1509-17) the city was fortified by a new rectangular rampart devised by the Veronese engineer-architect Fra Giocondo but built by Bartomeo d'Alviano. This mid-16th-century chronicle includes plans of the city before and after this transformation.

WOOL

16 17 18 19

Four ex-voto panels showing miraculously cured men holding berets:

Man miraculously cured from a leg injury
early 16th century

Family kneeling at prayer in a landscape
early 16th century

The Madonna of Lonigo and a pilgrim holding a beret
1502

Miraculously cured young man with a nightcap
first half of 16th century

tempera on panel
Lonigo, Museo degli ex-voto - Madonna dei Miracoli, cats 21, 22, 29, 25

This group of 16th-century ex-voto panels illustrates four men giving thanks to the Madonna dei Miracoli of Lonigo for cures from ailments or injuries, attributed to the power of the miraculous image of the Virgin. In each case the lucky survivor has removed his beret as a gesture of respect in the moment of prayer. These images show the widespread popularity of the knitted berets with brims that were produced in the Veneto in this period, especially in Padua and Verona. Free of artistic pretension, ex-voto images are valuable for the light they throw on the lives of ordinary people.

20

Knitted beret
replica of a beret from c. 1500-50 (Victoria & Albert Museum, London, coll. no. 1566-1901) made by the curator Deborah Howard

In addition to his trade as a miller in Padua, Palladio's father Pietro della Gondola is described in documents as a *birrettarius*. The production of knitted berets and stockings was especially important in both Padua and Verona: indeed by 1614 knitting was said to be the most important industry of Padua. A cache of 16th-century knitted berets discovered in London shows the type of headware made in the Veneto. The recent invention of the purl stitch allowed the smoother "stocking stitch", as seen in this replica of a well-preserved example in the V&A Museum, London.

21

Venetian manufacture
Pair of stockings
19th century
knitted wool
Fondazione Musei Civici di Venezia,
Museo di Palazzo Mocenigo, inv. Cl. XXIV no. 0775

In the 16th century knitted stockings in both wool and silk began to replace those made with woven cloth in both Verona and Padua. The so-called "stocking stitch" allowed a smooth surface, as seen here, and the elasticity gave a better fit. Italian stockings were recorded in London as early as 1564. Few examples survive from the 16th century – apart from elite items such as the red silk stockings of Eleonora of Toledo now in Palazzo Pitti in Florence – but this later woollen stocking shows the type that was used widely for several centuries.

22

View of the textile mill of Constanzo Colles at Follina (Treviso)
1819
engraving
Milan, Civica Raccolta delle Stampe
"Achille Bertarelli" - Castello Sforzesco, Pubblicità 1, Tessuti 1833-34

This business flyer advertising the Costanzo Colles woollen mill in Follina shows the whole production complex: the 17th-century headquarters, together with the ancillary buildings at the back, which housed the various phases of wool manufacture. The palace, overlooking the town square, recalls the typology of the typical Venetian merchant's residence. Adjoining it is a lower wing containing the offices and shops of the company. In the large courtyard with arcades on both sides, the *chiodare* (racks) and the loggia for drying cloth are clearly visible. The side annotations bear witness to a particularly successful period in the history of the factory, which eventually closed in 1893.

The Sgarzerie, Verona
2022
video by Fausto Caliari and Davide Provolo
drone operator: Daniele Pernigo

Wool-production was one of the chief sources of prosperity of Verona in the late medieval period, and by 1470 it employed a third of the workforce. The Corte delle Sgarzerie lies in the heart of the city near the Piazza delle Erbe. In 1408 around 60 artisans were in operation around the courtyard, principally the *garzatori* who carried out the final teaselling of the woollen cloth. The central loggia dates back to the 14th century, though it underwent later modifications. Here the guild of woolworkers inspected the finished cloth, while mechanical teaselling probably took place on the upper storey.

SILK

23

Domenico Campagnola
The preparation of raw silk in a villa
first half of 16th century
pen and ink on paper
Firenze, Gallerie degli Uffizi, inv. GDS no. 1786 F

This drawing, attributed to the painter Domenico Campagnola (1500-1564), illustrates the preparation of raw silk in the portico of a country villa, a space adapted for use as a silk-workshop. The women at the left side are shown picking the mulberry leaves and collecting the silk worms. In the centre, a woman is supervising the heating of the basin of water for soaking the cocoons before unwinding the raw fibres on to wooden reels on the horizontal axle above. This drawing may be a preparatory drawing for a fresco in a villa.

24

Man-powered machine for twisting and spinning silk from the "Trattato dell'arte della seta"
1487
pen and water-colour on paper
Florence, Biblioteca Medicea Laurenziana, Plut. 89 sup. 117, fol. 7v

First recorded in Tuscany in the 13th century, cylindrical machines powered by a treadmills for twisting and spinning silk allowed a large number of threads (80-150) to be twisted to a uniform degree. Such devices guaranteed greater productivity and a notable saving of human energy, in contrast to the traditional hand-operated spinning wheel. This is the first known visual representation of a manpowered machine of this kind, with 24 spindles for winding the thread, arranged in groups of three around the circular frame.

25

Sebastian Bonotti (surveyor)
Spinning mill for making warp thread "alla bolognese" on the river Sile at Treviso
2 July 1655
pen and brown ink on paper

Archivio di Stato di Venezia, Provveditori ai beni inculti, Disegni, Treviso, rot. 417, mazzo 12, dis. 3

This scale drawing of a silk-spinning mill *alla bolognese* in Treviso indicates that the four-storey structure rose to over 12 metres in height, the altitude needed to contain the huge water-powered cylindrical mill. This technology, which produced a warp thread of high quality, had a rapid expansion in the second half of the 16th century, even spreading to the waterways in the city centres of the Veneto.

26

Iseppo Cuman (surveyor)
Map of the Brenta at Bassano
8 February 1666 m.v. (1667)
pen and wash on paper
Archivio di Stato di Venezia, Provveditori ai beni inculti, Disegni, Vicenza, rot. 438, mazzo 28B, dis. 2

This drawing was made at the request of the nobleman Iseppo Bonfadini who wished to build a hydraulic system to power his silk-spinning mill for making *orsoglio alla bolognese*. The sites where the applicant proposed to build his structures for silk production (the embankment, the water-wheel for raising the water from the Brenta, and the *roggia* or mill-race) are shown to the right of the covered bridge, not far from the Porto di Brenta, the public mooring facility that sustained the economic life of Bassano. The Roggia della Rosa, constructed in 1365, is visible on the right.

27

Antonio Gaidon (surveyor)
Silk-spinning mill of the Roberti family at Nove (Vicenza)
1800
pen and wash on paper
Archivio di Stato di Venezia, Provveditori ai beni inculti, Atti, b. 493, dis. 3

The buildings illustrated here were probably erected after the first concession issued in 1671 to Roberto Roberti for the construction of a silk-spinning mill *alla bolognese*, powered by the waters of the nearby Brenta river. Traces of the great proto-industrial structure are still identifiable today in the houses facing the main road.

28

Fabbrica Marasca (Vicenza)
Samples of woven cloth
c. 1775-1800
scrap-book of 128 pages, with a semi-rigid binding of parchment on cardboard
Vicenza, Museo Civico di Palazzo Chiericati, Fabbrica Marasca di Vicenza, Inv. F7, fols 98-99

This book of samples of silk textiles comes from the legacy of the Fabbrica Marasca, donated to the city of Vicenza in 1873 by the cleric Pietro Marasca, the last heir to the Vicentine silk business that bore his name.
Building on the city's renown for silk production dating back to the 15th century, the Fabbrica Marasca manufactured fine silks for use used in clothing, furnishings, table linen, liturgical vestments and military uniforms. This collection of samples testifies to the variety of textiles produced in the factory in the 18th and 19th centuries. The pages displayed here show pieces of silk taffeta woven in delicate patterns and bright colours, some including the selvage or border.

Silk-spinning mill "alla bolognese" from the Musei Civici di Bologna
2022
video by Fausto Caliari and Davide Provolo

In 1341, taking advantage of the existing network of canals, the first water-powered silk-spinning mill was established in Bologna. The cylindrical, rotating silk-spinning machine, invented in Lucca, allowed the even twisting and spinning of the silk fibres in large quantities. The use of this innovative technology expanded rapidly, and by the mid-15th century similar hydraulic silk-spinning machines were already in action in Verona and Vicenza. This half-size working model illustrates the enormous scale and complexity of the machinery.

ROOM 2: WATER

THE SHIFT TO THE COUNTRY-SIDE

THE IMPORTANCE OF NATURAL SPRINGS

MILLS: GRAIN AND RICE

29

Villa Barbaro at Maser (Treviso), model
Made by the CISA Andrea Palladio on the occasion of the Palladio exhibition of 1973, and donated to the Ministry of Culture in 1996

Palladio's Villa Barbaro at Maser, built for Daniele and Marcantonio Barbaro in *c.* 1554-56, replaced the house on the estate inherited from their father Francesco Barbaro. Lying on the spring-line that runs through the Venetian *terraferma*, the property was well-supplied with water. Between 1513 and 1528, legal documents mention the existence of an *appoteca lanificium* (wool-manufacturing workshop) or *fulone* (fulling mill) at Francesco's villa, but his sons do not seem to have continued this enterprise.

30

Andrea Palladio
Villa Barbaro at Maser, in "I quattro libri dell'architettura"
Venice 1570
Vicenza, Biblioteca del CISA Andrea Palladio, CAP C XVI 11

In book II of his celebrated treatise, Palladio illustrates his own designs for villas and palaces. His description of the Villa Barbaro at Maser proudly explains the circulation of water flowing by gravity through the complex: from the spring-fed nymphaeum at the back, through the kitchens, down to the gardens in front of the house – where a fishpond on either side of the driveway supplies drinking fountains on the public street – before finally irrigating the orchard on the far side the road.

31

A young woman falls into the river near a mill
16th-17th century
tempera on panel
Lonigo, Museo degli ex-voto - Madonna dei Miracoli, cat. 171

This votive panel shows an accident suffered by a young female miller who slipped into the river where the current swept her dangerously close to the mill-wheel. Although terrified, she invoked the miraculous intercession of the Madonna di Lonigo to save her from drowning, her prayers echoed by her mother who had run to the scene. The image underlines the typical simplicity of rural mill buildings, the potency of hydraulic energy, and the importance of the role of women in proto-industrial activities.

32 **33**

Two mechanisms for water-mills, models: Water-wheel fed from below and connected to a gear wheel, for example for grain mills Water-wheel fed from above and connected to a camshaft, for example for paper-mills
2022
executive drawings: Simone Baldissini
model-maker: Ivan Simonato
Vicenza, Palladio Museum

SAWMILLS

34

Anonymous, after Francesco di Giorgio
Manuscript with drawings of machinery
c. 1500-50
Vicenza, Biblioteca civica Bertoliana, DS 48

This collection of drawings, similar to the one at the beginning of the exhibition, shows among others the representation of a sawmill using the technology known as *alla veneziana*. By a system of levers and winches the log of wood is moved forward along the trolley to keep its surface in contact with the blade of the saw. The invention is often attributed to Leonardo, but Francesco di Giorgio preceded him and may even have depicted known practice.

35

Sawmill "alla veneziana", model
c. 1750
wood
Kunstsammlungen und Museen Augsburg, Maxmiliansmuseum, inv. no. 9684

This example from in Augsburg shows the type of small working model submitted to the Venetian Senate to support applications for patents (*privilegi*). It illustrates the working of the sawmill *alla veneziana*, in which a rod-and crank mechanism transforms the circular rotation of the water-wheel into the vertical sawing action.

Sawmill "alla veneziana" at Valli del Pasubio (Vicenza)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

This sawmill in the village of Seghetta (little saw) dates back at least to the 18th century, but may be even older. As early as the 14th century, flour-mills, sawmills and fulling-mills made use of the swift-flowing waters of the Valli del Pasubio. The saw is driven by an overshot water-wheel (*a coppedello*).

PAPER-MILLS

36

Cartiera Tiepolo Remondini at Oliero (Vicenza), model
Valbrenta, Museo delle Cartiere di Oliero

The original mill, established in 1671 and rebuilt after a fire in 1878, now serves as a museum. The water-wheels were powered from the waters of the nearby Grotte di Oliero. Linen rags provided the raw material for paper-manufacture. After soaking in vats of water the rags were pounded by water-driven pestles activated by a cam-shaft (an axle with projecting flaps to raise the hammers). Thin films of pulp extracted in rectangular frames were compressed in a screw-press between layers of felt to remove the excess water before being coated with glue. The finished sheets were hung out to dry in the attic, ventilated by louvred shutters.

37

Vincenzo Coronelli
Tavola topografica della riviera di Salò, in "Corso geografico universale"
Venice 1692
Venezia, Biblioteca Nazionale Marciana, 285 C 21

This topographical engraving by the Franciscan friar Vincenzo Coronelli (1650-1718) illustrates part of Lake Garda. Above Toscolano and Maderno on the west bank of the lake lies the Valle delle Cartiere, a long-established site of paper production on the banks of the mountain stream called the Toscolano. This fast-flowing river runs through the Brescian hills along the Valvestino valley, following a tortuous route of around 20 kilometres, flanked by numerous paper-mills and forges.

38

Paper-mill of Dueville (Vicenza)
Samples of "rag-paper, blue paper, sugar paper, and wrapping paper" with the watermark IP (presumably Iseppo Porto)
1768
Archivio di Stato di Venezia, Cinque savi alla mercanzia, Prima serie, b. 464

Powered by a spring-fed water supply, paper production in Dueville dates back to the Quattrocento. In the 1550s Paolo da Porto, owner of one of the paper-mills, erected a villa generally ascribed to Palladio. An inventory of 1588 describes the contents of two paper-mills in the area then owned by Iseppo da Porto (not closely related to the eponymous patron of Palladio's palace in Vicenza). The paper-mill at Dueville remained in the hands of the Porto family until 1815. These samples of the paper dating from 1768 display a watermark showing the monogram of the owner 'IP'.

39 **40**

Manufacture of northern Italy
Doublet
c. 1575-1600
leather, embossed with fleur-de-lys ornament
Fondazione Musei Civici di Venezia, Museo di Palazzo Mocenigo, inv. Cl. XXIV no. 1736

Venetian manufacture
Men's footware
c. 1700-1725
black leather
Fondazione Musei Civici di Venezia, Museo di Palazzo Mocenigo, inv. Cl. XXIV no. 2672

This man's doublet embossed with fleur-de-lys ornament is an example of the production of luxury items in leather in the Veneto in the Cinquecento. Moreover, at this time shoe-making was one of the principal trades of Bassano. The cattle fattened on the summer pastures of the *altopiano* of Asiago provided the raw materials for a thriving leather industry in centres such as Bassano, Arzignano and Venice. The hides were treated in the tanneries at sites such as Gallio, where the plentiful supply of tree-bark could be crushed by water-power to produce tannin.

ROOM 3: FIRE

41

Francesco Bassano
Allegory of the element Fire
c. 1585-1590
oil on canvas
Banca Popolare di Vicenza S.p.A. in L.C.A.

This huge painting of *The Element of Fire*, also known as *Vulcan's Forge*, is one of several sets of canvases by Francesco Bassano (1549-1592) depicting the four elements: Earth, Air, Fire and Water. In the centre we see the blacksmith with his hammer raised, about to beat an arrowhead on the anvil, while behind him, his younger assistant heats iron rods in the forge. In front we see an array of metal artefacts, ranging from armour on the left to candlesticks and copper pots on the right. Ore is smelted in the foundry in the upper left, and two further smelters are visible in the distant background.

42

Vanoccio Biringuccio
Della pirotechnia
Venice 1540
Vicenza, Biblioteca civica Bertoliana, X 17.3.5

The seminal work of Vannoccio Biringuccio (1480-1538/9), *De la pirotechnia*, published posthumously in Venice in 1540, was the first comprehensive printed treatise on metallurgy. Technical knowledge crossed the Alps in both directions: Biringuccio twice visited Germany, while the German mining engineer Georgius Agricola later acknowledged his debt to Biringuccio in his *De re metallica* (1556).
Biringuccio was far more practical in approach than the late medieval alchemists who preceded him, for his ideas were grounded in first-hand experience. He recommended the use of water-powered bellows for smelters, as illustrated here.

KILNS FOR LIME AND BRICKS

43

Giovanni Antonio Rusconi
Della architettura

Venice 1590
Vicenza, Biblioteca del CISA Andrea Palladio, F.A. II 9

Giovanni Antonio Rusconi (*c.* 1520-1579) was a Venetian architect and hydraulic engineer. His treatise, published posthumously, is an incomplete commentary on Vitruvius's *Ten Books,* illustrated by woodcuts that often reflect building technology of his own time. The woodcut on the left illustrates Vitruvius's chapter explaining how to make bricks from air-dried clay, while the right-hand plate shows the various shapes and sizes. Vitruvius recommends that bricks should be made in spring or autumn, and dried for two years. In the Veneto by the 16th century, however, bricks were more often fired in kilns.

44

Moulded brick for the columns of Palladio's Palazzo Chiericati, Vicenza
16th century
clay
Vicenza, Museo Civico di Palazzo Chiericati

To shape columns constructed in brick, special bricks had to be produced in the form of a segment. The tapering of the shafts was left to skilled craftsmen, who had gradually to decrease their diameter by reducing the depth of the mortar bed in parallel fashion; a coat of plaster then covered up the small imperfections.

45

Francesco Nanti
Brick kilns of the monastery of Santa Giustina, in "Libro delle Possessioni e delle Chiusure della Corte di Maserà"
1665
pen and water-colour on paper
Archivio di Stato di Padova, Corporazioni religiose soppresse, Santa Giustina, b. 565, c. 25r

Bricks were often made at the building site, as in this brick kiln located on a plot of land adjoining the monastery of Santa Giustina in Padua. The kiln is of the usual rectangular shape, with openings at the bottom for lighting and ventilating the fire. In this case the open top is protected by a canopy. The equipment, listed at the top of the page, was provided by brickmakers from Maserà. The items shown include moulds (for shaping roof-tiles, bricks and floor-tiles), a pallet for scooping clay, a bucket, a tub, a container for ash and an iron poker.

46

Bricklayer falls from the roof of a house under construction
1545
tempera on panel
Lonigo, Museo degli ex-voto - Madonna dei Miracoli, cat. 67

This votive panel shows an accident suffered by a bricklayer because of an attack of dizziness while he was laying tiles on the roof of a brick house. Bricks and clay-tiles were widely-used building materials in the period. Another characteristic feature of the landscape of the Venetian *terraferma* is the cultivation of rows of mulberry trees in the background, evidence of the widespread rearing of silk-worms for the silk industry.

FOUNDRIES AND CHARCOAL-BURNING

47

Zorzi de Christofolo
Charcoal-burning site at the Bosco d'Alpago (today Foresta del Cansiglio)
1643
pen and water-colour on paper
Archivio di Stato di Venezia, Provveditori e sopraprovveditori alle legne e ai boschi, Amministrazione forestale veneta, b. 85, dis. 1

The forests of Alpago were the most precious source of timber on the Venetian *terraferma,* and were carefully conserved by the Republic to ensure their sustainability. This view shows the production of wood to be made into charcoal – mainly to supply the forges of the Arsenal in Venice. The annotations on the drawing illustrate the stages in the production: from the cutting of the beech-wood, to the slow burning in the characteristic kilns known as *poiatte*, to the loading onto rafts near the lake of Santa Croce to be floated down-river to Venice.

48

Mine and smelters at Collio in Val Trompia
1778
pen and brown ink on paper
Archivio di Stato di Venezia, Deputati alle miniere, Disegni, dis. 11

In this 18th-century image of the "Mine of the King" at Collio in Val Trompia, the letter A indicates the interior of an underground mine with a miner in action. In the centre, at letter F, the drawing shows the *regane,* the local name for the smelters for extracting metal from its ore. Inside these masonry structures the iron ore was heated to the necessary temperature (around 700° C) to produce ferrous oxide. This material would then be transferred to the blast-furnaces further down the valley, where it was heated to 1,500° C to transform it into ingots of pig-iron to be sent to the iron-works in the plains.

49

Osvaldo Monti
Officina Battestin a Dont, in "Illustrazioni di Zoldo per servire alla guida provinciale"
1881
pen and water-colour on paper (sketchbook)
Belluno, Museo Civico, inv. MCBL 7089

The water-colour on page 12 of this sketchbook by the Bellunese painter Osvaldo Monti (1819-1904) shows the interior of a forge in Val di Zoldo, the mountainous area noted for its metal-working. Because of the terrible damage caused by the great flood of 1966, which destroyed most of the buildings along the river Maè, no trace survives of this workshop for the production of nails.

ARMS AND ARMOUR

50

Lombard manufacture
Infantry breastplate
c. 1570-80
embossed steel with incised ornament of vine tendrils and volutes on a background of small fish-scales
Fondazione Brescia Musei, Museo delle Armi "Luigi Marzoli", inv. no. 946

This breastplate is characteristic of the high-prestige infantry armour produced in Brescia in the 16th century, taking advantage of the local production of iron and steel. It probably belonged to a member of the Martinengo family, who included some of the best military tacticians in the Venetian army. In contrast to the more angular style of German armour, north Italian workshops designed more rounded forms. The refined gilded decoration covers the entire surface with arabesques and stippling, incised into the surface of the metal.

51

Andrea Ferrara (the blade)
Military sword
c. 1580
steel partly inlaid with filaments of gilded iron
Milan, Museo Poldi Pezzoli, inv. 2536

The names inscribed on the blade of this sword allow its attribution to the sword-maker Andrea Ferrara, active in Belluno in the mid-16th century. Belluno was one of the major centres of production of steel weapons on the Venetian *terraferma.* Manufactured using iron from the Val di Zoldo and crafted in the forges of Feltre, Serravalle and Belluno, these arms were sold both within Italy and abroad. In 1578 Ferrara signed a contract with two merchants from London to supply as many as 72,000 swords in ten years.

FORGES

52

Titian (Tiziano Vecellio)
Orpheus and Eurydice
c. 1510
oil on panel
Bergamo, Accademia Carrara, inv. 81LC00179

This early work by Titian shows two scenes from the Ovidian story of Orpheus. In the left foreground Eurydice is bitten by a deadly bite from a dragon, while on the right Orpheus tries to rescue her from Hades, indicated by the structure in the right. Usually presumed to depict a city in flames, in reality this "inferno" shows a lighted blast-furnace flanked by water-wheels

for operating the bellows. Blast-furnaces of this type, used for the first stage in the "indirect method" of refining iron ore, were established in the mountains above Belluno in the 15th century to process the iron-ore mined at Fursil. The artist probably knew at first hand the foundries above his homeland in Cadore, such as those at Selva di Cadore, Castello d'Andraz and the upper Agordino.

53

Tools for carpenters, blacksmiths, shoemakers, farmers
19th century
Grancona, Fondazione Carlo Etenli,
Museo della Civiltà Contadina

Nails, pincers, hammers, vices, hand drills, chisels, hoes, shovels, sickles, pliers are some of the everyday tools made until the last century in the smithies of rural settlements, preserving the traditional production methods.

Maglio di Breganze (Vicenza)
2020
Video by Fausto Caliari and Enrica Rabacchi
Drone operator: Daniele Pernigo

This hydraulic forge, probably built in the later 16th century, lies on the *roggia Breganze*, a medieval canal fed by the waters of the river Astico. The *maglio* forms part of a small group of buildings that also included a sawmill: both are depicted in a map of 1635. The *maglio* was extended after 1635, and its appearance was again recorded in a map of 1710, showing a configuration similar to the present-day structure.

ROOM 4: EARTH

MINES

KAOLIN

54

Da Sesto workshop
Processional cross
c. 1425-50
silver, embossed and gilded
Vicenza, Museo Diocesano "Pietro G. Nonis",
inv. no. FAJ0513

This beautiful processional cross, made for the cathedral of Vicenza, is attributed to the workshop of the da Sesto family of goldsmiths. Active in Venice these craftsmen not only produced precious liturgical objects but also worked in the Venetian Zecca (Mint). This activity probably brought them into contact with the silver mines of the *terraferma*, such as those of Tretto, north of Vicenza. Made of gilded silver, the cross is decorated with refined ornament designed to catch the light from all sides. The body of the crucified Christ is left ungilded to emphasise its deathly pallor.

55

Giacomo Antonio Brianatti
"Pozzo di San Patrizio" of the mines at Tretto (Schio, Vicenza)
1681
pen and wash on paper
Archivio di Stato di Venezia, Deputati alle miniere,
Atti, b. 283

This drawing of the labyrinth of underground tunnels was attached to a report of 1681 by the inspector of mines, Carlo Angeli, to the Council of Ten in the hope of reviving the extraction of silver on the mines at Tretto, suspended since the previous century. His request was not granted. The subsoil of this area, situated above Schio, also yielded a fine clay known as *caolino*, used primarily in the production of ceramics. Thanks to its abundance and low cost, the mines of Tretto remained in operation for over half a millennium, until extraction ceased in the 1970s.

56

Georgius Agricola
De re metallica
Basel 1556
Bassano del Grappa, Biblioteca Civica, magazzino 13.D.11

Profusely illustrated with woodcuts, this posthumous treatise by the German mining engineer Giorgius Agricola (1494-1555) includes chapters on surveying and prospecting, on excavating, ventilating and draining tunnels, on the transport of ores, and on the building and operation of furnaces. Written in Latin to reach an international audience, the book helped to transmit the latest German mining technology to the Veneto. Agricola describes and illustrates numerous mechanical devices, such as pumps, bellows, lifting gear and stone crushers, powered by water-wheels, animals, men, or even wind.

57

Giovanni Battista Dragonzino
Lode a Schio
1801-1849 (copied by Vincenzo Gonzati from the original of 1526)
Vicenza, Biblioteca civica Bertoliana, Ms. 1807

This poem, written in 1526 by Giovanni Battista Dragonzino of Fano, adopts an almost Dantesque perspective to describe the manufacturing town of Schio, north of Vicenza. Whereas the beauty of the natural landscape evokes an earthly Paradise, the author compares the furnaces of the mining operations at Tretto to the house of Vulcan: "I can still hear in my ears the roar/ Of bellows, wheels and hammers; / [...]/ the whole site trembles and shakes/ [...]/ [the workers] seem like nude black devils."

58

Giuseppe Gorlino
Descrittione delle minere del Tretto
1675 (copied from the original of 1560)
Vicenza, Biblioteca civica Bertoliana, Ms. 3555

Iseppo Gorlin, a notary from Tretto, was the great-grandson of the German miner Michele da Baviera, who had introduced water-powered bellows to the site before 1500. Gorlin's account, written in 1560, is infused with myth and superstition, but he also records crucial details of the latest mining technology, often reflecting German innovations. By now the silver deposits had been largely exhausted, but the extraction of *caolino* or *terra bianca* was becoming ever more important. This later copy of Gorlin's text includes a striking frontispiece showing three churches of Tretto and a line of trees.

59

"Casone" for drying the "pani di caolino"
2022
executive drawings: Massimiliano Maculan
model maker: Ivan Simonato
Vicenza, Palladio Museum

After extraction from the underground mine, the white *caolino* was mixed with water to remove impurities. Lower down the slopes, the paste was shaped into small loaves (*pani*) which were dried in special open-sided barns with over-hanging eaves, shown in this small model. This unique type of building continued almost unchanged from the 16th to the 20th century, and as many as 27 surviving examples have been identified at Tretto.

60

Brenta river pebbles from Nove (Vicenza), larger, and Fontaniva (Padua)

The plentiful white limestone pebbles deposited on the bed of the river Brenta provided a valuable raw material for industrial use. Because of gradual erosion by the water their size decreases during the river's descent. The larger pebbles from Nove show the preferred size for use in the production of ceramics. The stones were ground into a powder in the nearby stone-grinding mill or *pestasassi*. Further downstream the smaller pebbles from Fontaniva show the size that was most suitable for use in a limekiln.

QUARRIES

61

Accident at the building site of a house under construction
1860
oil on panel
Lonigo, Museo degli ex-voto - Madonna dei Miracoli, cat. 354

This votive panel depicts the dramatic events caused by the breakage of the pulley rope on a building site. The heavy stone cornice has broken the wooden scaffold, knocking a builder into mid-air, and causing panic among his fellow-workers. That the unfortunate man escaped unharmed was attributed to the intervention of the Madonna di Lonigo, represented on the upper right.

Le Priare, Montecchio Maggiore (Vicenza)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

This quarry, excavated beneath the hilltop Castles of Romeo and Juliet, is the source of the best local building-stone, a type of limestone known as *pietra tenera di Vicenza*, prized for its resistance to weathering. Known since Roman times, the quarry's main exploitation lasted from the later 15th to the 19th centuries. Although the stone hardens on exposure to air, it is soft enough to be extracted manually from the quarries using hand-saws.

CERAMICS

62 **63**

Antonibon, factory Nove (Vicenza)
Pharmacy jar with spout and handle
and *Pharmacy jug*
c. 1740-70
maiolica
Bassano del Grappa, Musei Civici, Palazzo Sturm, Museo della Ceramica "Giuseppe Roi", inv. nos 2535 and 2536

In 1669 ceramicists of the Manardi family submitted samples of their pottery to the Venetian Senate and were granted a *privilegio* for 25 years allowing them to establish a new centre of production in Bassano. This site still survives close to the existing Museo della Ceramica in Palazzo Sturm. The Manardi enterprise became especially well-known for its pharmacy jars, decorated in cobalt blue on a gleaming white background. In the 18th century, similar jars were produced by the Antonibon factory in Nove, such as the two pieces displayed here.

64 **65** **66** **67**

Antonibon factory, Nove (Vicenza)

Dish decorated with multicoloured flowers
c. 1700-50
maiolica

Oval dish decorated with multicoloured flowers
c. 1700-50
maiolica

Round plate decorated with a blue flower
c. 1700-50
maiolica

Oval plate decorated with blue flowers
c. 1700-50
earthen ware

Nove, Museo Civico della Ceramica "G. De Fabris", Dep. 31 and 54, inv. nos 1999.15 and 1999.16

In 1727 the production of ceramics spread to Nove, further down the Brenta, where Giovanni Battista Antonibon established the factory that still operates today. The plates exhibited here show how the Antonibon sought to emulate the whiteness and delicacy of Chinese porcelain, with its characteristic blue and white decoration, known from luxury imports. The other dishes, with their flowers of yellow, green and manganese, reveal the influence of Turkish Iznik ware. These four dishes illustrate the large-scale production of middle-range ceramics for domestic use, their brilliant whiteness enhanced by the addition of *caolino* from Tretto.

68

Antonibon factory, Nove (Vicenza)
Plate decorated "a ponticello" (with small bridge motif)
c. 1740-70
Bassano del Grappa, Musei Civici, Palazzo Sturm, Museo della Ceramica "Giuseppe Roi", inv. no. 153

Production at Nove flourished under the direction of Pasquale Antonibon, who took over his father's factory in 1751. The characteristic styles of hand-painted decoration became more colourful and ornate, especially after the introduction of a new technique for firing the painted decoration at a lower temperature. This scalloped dish, adorned with a Chinese-style landscape, represents the type known as *a ponticello* because of the inclusion of sinuous bridges of vegetation surmounted by ornate railings or exotic oriental buildings.

Pestasassi Stringa, Nove (Vicenza)
2020
video by Fausto Caliari and Enrica Rabacchi
drone operator: Daniele Pernigo

This mill, founded in the 18th-century, grinds white quartz and limestone pebbles from the bed of the Brenta for use in the production of ceramics. It is powered by the *roggia Isacchina,* diverted from the Brenta in the Middle Ages. A nearby sawmill was recorded in the 14th century, and a *maglio* (water-powered forge) built in 1423 is still visible today. The production of crushed pebbles supplied the local ceramics industry founded at Nove by the Antonibon family.

Ministero della Cultura
Direzione regionale Musei Veneto

Centro internazionale di studi
di architettura Andrea Palladio

Water, Earth, Fire. Industrial Architecture of the Renaissance in the Veneto
curated by Deborah Howard
Vicenza, Palladio Museum,
12 November 2022 – 12 March 2023

Under the patronage of the

MINISTERO DELLA CULTURA

With the contribution of:
Friends of Palladio
The Gladys Krieble Delmas Foundation

Sponsors of the CISA Andrea Palladio as Participating members:
FASE SpA
LD72 Srl

as Participating supporters:
Confindustria Vicenza, Sezione Costruttori Edili e Impianti
OTB Foundation
Zambon Company SpA

Sponsors of the Palladio Museum through Art Bonus:
Cristiano Silei
Viacqua SpA
Palladio Group SpA
RM Holding Srl

www.palladiomuseum.org