Chapter 3: BUILDING ARTS, THE TECHNIQUES AND THE MEN

We see that local craftsmanship can be revived rather quickly; the priority is less to resume its teaching than reclaim its former prestige.

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THE TECHNIQUES AND THE MEN

Two key words: local and ancestral

The building arts include materials, technique and know-how. This means both the construction and the competence of the builder are involved. We are in the field of the house built with local materials.

The notion of living space cannot be dissociated from economic concerns. The materials used are extracted, produced and processed near the site of construction. In this respect, the Mediterranean area conceals a very large variety of environments (relief, sub soil, climate, etc), providing a multitude of resources, in addition to consequences in terms of construction constraints. In a pre-modern community, prior to the introduction of the train or truck, heavy construction materials could not be transported except at outrageous cost, and were thus out of reach for traditional architecture. This constraint of minimum displacement lead builders to adapt the materials they had at hand, whatever their quality or performance, in an area limited by the effective range of an animal-drawn cart. The resulting problem is an imperfect material, sometimes imposed, sometimes chosen, that must nonetheless result in a good construction. This encourages builder’s ingenuity in developing his implementation technology: a defect is thus compensated by an added value.

The techniques are ancestral and their evolution is slow, as long as new materials or new influences do not intervene, or as long as none are assimilated by the community. These techniques are characterised by simple systems of implementation and a constant attention brought to economical and efficient solutions. They can vary, adapting to the local needs of the area where they are executed. In exceptional situations, they can include prefabricated products produced far from the site. (1) Know-how is transmitted orally through training and experience. Generally no written track is kept, but a continuous use ensures a natural transmission from one generation to another. It is appropriate to distinguish two forms of building arts know-how: trades and practices. The trade results from training, and defines a commercial professional business. It includes all the tasks carried out by the same individual. (2) The practices / crafts are a subset of the trades. They are based on proficiency. These segments of competence are used to carry out work outside a market spirit, as in self-construction for example. (3) Thus, competence is distributed between the builder and the user. This pair gave birth to both prowess and simplicity, as well as great continuity, a homogeneous bond in the very matter of housing that represents over nine tenths of all old construction.

CORPUS focused on the envelope and structure of a construction: the wall and the rendering, the floor and the vault, the frame and the roofing. Our target is, as a result, the main parts of a house. The corpus documentary does not include anything on pavements, for example, nor equipment such as doors and windows, nor decorative devices. These choices were made right from the start, in accordance with the means at our disposal for gathering information. It is thus a question of gathering and describing all the information in the same data base; a thorough range of constructive devices which were developed and used throughout this extremely varied area, pointing out the common characteristics, the possible analogies and the true points of difference. We also try to find the reasons that explain the abandonment of simple and satisfactory practices. But this approach necessarily projects us into the future, by trying to understand the mechanisms of technological developments and new practised trends.
While the main traits and shapes of a construction are the result of culture and tradition, building arts condition the aspect, texture, and colour of a house.

A language, an ambition, an abundant source of travelling techniques.

Building and image are always intimately interrelated in a construction. All we need is to imagine a structure built with other materials, other techniques and other final touches: the result would be entirely different. This proves that building arts are not neutral, that they are one of the determining points of traditional architecture, that they are one of the vectors of architectural expression. This world of construction is a world of means. The builder adapts to what is available to dispatch loads, to cross space between two supports, or to ensure the waterproofing of the building. The builder chooses his solution impregnated with local standards of architectural shapes. There is no technology which would bring a single formal solution. A builder from another culture having the same technical means at his disposal, would produce a very different building from his counterpart. Each builder is rooted in his own traditions and architectural reflexes, in an implicit and powerful way. Building arts are more a tool at the service of a project than an actual language that would determine architecture. This applies to traditional architecture which does not seek technical innovation. It is adapted to current constraints of materials available, and with a modest budget it is restricted to minimal thickness or maximum spans. This is not true for monumental architecture which - successfully building larger, higher and broader constructions - seeks technological performance as a way to renew shapes, while freeing itself from constraints, thus developing exceptional solutions. The common house then copies and uses these solutions, adapting them to its own scale.

The opinion we cast on old, traditional construction is no longer strictly "a developer’s point of view". It is henceforth seen through the eye of a historian, sometimes a patrimonial point of view, acquiring a value of testimony. Seen this way, building arts are an indicator of evolution, enabling the interpretation of the layers of a building. Its “in situ” analysis is an invaluable guide through construction campaigns, but, even more importantly, the ambition of the builder. Popular habitat coincides with modest means. But limited means do not imply indigence. In substitution for expensive materials, the builder compensates for what he lacks. He imitates and produces a replacement solution. When supplies are not within reach, a construction requires more labour and effort, therefore cumulating added value. Stone or brick loses its banal connotation and achieves the level of a nobler material.

No money for marble? A polished stucco will replace it. The know-how of the mason will enable him to proportion, draw up and shine this paste making it as admirable as the inaccessible marble.

Not only is there intelligent labour and performance, but there is also the will to recreate a palace at home. The rich, aristocratic or princely house is only a partial model for an ordinary dwelling, an inspiration (through the elegance of its solutions), and at the same time a sign of freedom as it represents unlimited means. This is one of many veins. The inspiration of a builder does not result simply from adapting to a wealthy house concept. We insist on the social dimension which often entices the European builder. Through a play of effects, composition and finishing he invents construction solutions that he would never have imagined had he been possessed of greater means. (4) The interesting point here is how the building expert, the sole actor with his building arts as his only tool, reaches a level of cultivated and elaborate architecture.

Such observations prove that the trilogy, materials + techniques + know-how, produces far beyond a simple piece of work; it can bring immaterial assets to the work of the craftsman.

This value is engraved in the very matter of his construction; it is a testimony to richness that gives more meaning to his accomplishment. Considering the many civilisations that it contains, the Mediterranean area is narrow. It nevertheless concentrates much of humanity’s building arts (all that
could be used to build was used). This variety of materials used is evidenced both through influence and availability. The conquests for economic, political or spiritual control conveyed solutions: but are they alone in determining local use? We see the techniques of Ottoman wooden framework as far as Algeria, Phoenician mud techniques in Portugal, Roman techniques, followed by Romanesque with the crusades, small stone material in the Middle East, techniques of the Arab arch as far as Andalusia. These techniques were imported and integrated by local populations who in turn exploited and adapted them to their way of living. Here, culture dominates geographical identity, which explains why Portugal, in this view is more Mediterranean than Atlantic. These contributions, merged but visible, create a technical syncretism that redistributes a nomad know-how in a widely travelled Mediterranean area. The shape of construction follows cultural schemes: organisation of the layout, relations between "necessity, convenience and beauty" according to Vitruvius. The shape of construction is not universal but corresponds to the rules and models produced by a community. The construction of a house adapts to local materials (the variable element), and techniques + community know-how (the unchanging element). (5) Thus, the multiple physical resources (stone, earth, sand, wood) imprint a variety of aspects to small, very homogeneous construction areas that are very clearly differentiated from one another by different supply resources, while at the same time, common models prevail throughout large areas.

VERTICAL STRUCTURES: THE WALLS

Stone Walls

• Masonry laid in mortar

The variety of aspect is tremendous with regard to the types of walls and the finishing. In areas with rather soft limestone and sandstone, one finds ashlar and hewn stone, carefully sized (the stone cutter can replace the mason, for shaping and for laying). This beautiful style of cutting is found in commissioned or prestigious constructions, insofar as abundance and quarry proximity make building affordable. Less regular and extracted from a harder material (limestone, basalt or sandstone), dressed quarry stone is found in every country. Quarry beds often determine the height of the block, only four faces are reshaped. This technique produces straight laying courses, which are sometimes identical and regular in size.

The dominant material is rough stone laid in mortar, which requires little sizing. Dimension, shape, and nature of the stones produce a considerable variety of aspects for different kinds of masonry that belong to the same family. The shapes of the stones, ranging from random loose stones, rounded by stream currents when they are extracted from a torrent, to pseudo quadrangular when extracted from a quarry, generate a type of masonry that requires wedging in small elements making this a highly mortar consuming masonry. Walls range from more or less straight laying to perfectly adjusted courses of regular, bare material. (6)

In the Mediterranean area, the most common wall is made of stone.

It is usually thick, laid with mortar, and built by a mason.

• Dry stone

Dry stone is rather often used, mostly for small buildings. No mortar is used to correct faulty laying, obliging to a very good internal organisation of the blocks, with a slant oriented outwards for rain, and an excellent adjustment of the modules ensuring good stability to the elements: this is pure, native masonry. Rustic in appearance, sometimes even coarse, it is actually a great achievement, a summit of building arts.
Black, red, grey, ochre, white: the colour of the stones increases the materials collected adding aspects to the facing: a touch of variety and aesthetic vibration. When the material is left bare, it brings forth all the richness previously evoked. But the builder can also point, hollow out, bring relief, change colours, add fragments of red tile (Turkey), always introducing a very beautiful play of shade and light which changes according to the positions of the sun. Wash rendering or painted rendering applied directly onto the stone, enrich the language of wall finishing.

Bare, pointed, painted or rendered, there exist two approaches. First there is the waterproofing of the facing for the inhabited sections, and second there is the aesthetic approach. Very regular courses are visible from the start, whereas less regular courses are washed, rendered or both, to obtain a visual unity of the construction. But with fashion and styles, or the wish to renew the wall, "to change skins", the best masonry could be coated in a second campaign, without technical justification or necessity. Strangely enough, a wall that would require protection will sometimes lose its rendering without it being restored (voluntary chiselling or natural wearing).

• The Technique

Unless the wall is built directly on a natural rock base, one seeks good ground, digging a trench foundation. This buried work, seldom deeper than 50 to 70 cm, goes from the simple pitching of stone, the same width as the wall above ground level, to greater sized systems, built with large stones laid in mortar: a solid course which can be twice the width of the wall. A stone wall is seldom thin. It is only thin if the material allows it without compromising stability (for example: stones are cut with contact surfaces that are regular and adjusted) and it is not used for constructions higher than a single level, that is to say it should receive neither strong loads, nor thrust. (8) Stone walls are mainly thick, from 45 to 100, sometimes even 120 cm. Two facings linked or not with header binders, with a filling in the core of the wall, made of small elements and of mortar (more often earth than lime). (9) The carrying out is realised by laying horizontal courses: the two faces and the core are built simultaneously, on a bed of mortar spread beforehand. The largest modules define the height of the course, smaller modules are piled up in the same way to correct the level, and the joints are crossed to avoid long vertical cracks along the pointing sabre-like vertical splits. If need be, because of the random shape of large elements, very small modules wedge large stones so that the load transfers onto an incompressible material and not on mortar which is liable to distort. (10)

Well erected and well sized, all these alternative stone walls are very solid. Their only enemies are earthquakes, badly mastered thrusts, and water. Capillarity brings water from the ground and goes up in the bottom of the wall, slowly solubilising the binders (earth and lime) by corroding mortars and joints, thus creating empty spaces: this can disorganise the stone elements of the masonry to the point of instability, sometimes even ruin. From a seismic point of view, the main risk is brutal splitting. The areas concerned invented very smart and effective systems of horizontal wooden anchoring (throughout the Eastern Mediterranean), incorporated within the wall, that interrupts the course of the wall and can withstand violent quakes without compromising balance. But seismic interpretation is perhaps an overly mechanical view of this type of system: the traditional builder knows from experience that his construction is ensured of better stability with a more flexible, elastic-like device. (11)

The basic tools are extremely simple and common: sometimes only hands, a plumb line, a levelling tool and a chalk line for the geometry, trowels for mortars, and percussion tools (chisels) to shape the stones. Only cut stones require a more specialised range of tools to downsize the blocks and to finish the facings.

In a stone wall, everything is load bearing. But certain parts are more solicited than others, and they must perform (corners, lintels, jambs of openings, base plates). This in combination with the stock of available supplies, leads to the creation of many mixed solutions: stone and rubble, stone and pebbles, stone and brick, stone and wood. The distribution is done according to a kind of specialisation. For
the wetter or the more structuring parts, the best (more regular or dense) materials are preferred, while for the remainder a logic of mortar laying with filling is applied.

**Mud walls and terracotta brick**

- Earth, plentiful and universal (12)

Earth deposits cover the alluvial surfaces of the Mediterranean banks. The muddy basins near rivers produce fat clay, which is appropriate for the moulding of adobe bricks. Thinner grounds where sand and gravel are naturally present, provide materials for compacted earth construction, made dense by a systematic ramming of the earth material between forms. Because mud is easy to use, abundant and inexpensive (easier to carry out if one compares it with stone masonry, when the site allows for both choices), mud construction goes back far before historic times. The preparation tasks of mud material can be done by the user, making earth construction more readily available than any other technique requiring more expertise. The drawback of mud is that when it comes in contact with water, it becomes dangerously brittle. The construction will attribute durability to an absolutely compulsory protection against capillarity and rain. On the ground level it is stone which isolates from water, be it on a rock base, a stone or a brick foundation, or extended into a base plate above ground. To complete the protection, vertical facings can be rendered and often protected with a wash. (13)

Lime is not cheap: good stone, a furnace, fire, extinction and transport make it expensive. The concern of the builder is to use it sparingly. He either thins his mortar by using a maximum number of aggregates (sand, broken tile, gravel, rubble or broken brick) with finely adjusted grading, or switches the binding material to earth which is less expensive. Such a system makes it possible to erect very high walls: up to 6 m, a thickness of 60 cm is sufficient. Beyond 15 m in height (sometimes 6 levels) the base of the wall is at least 80 cm thick, and can be up to 120 cm. The wall is frequently thinned down while heightening, to limit downward loads, and to size the wall per level in accordance with what is later built on top. More attention is given to the contact between stones for corners. Larger modules are used, sometimes made from a different, better and more regular cut stone. They are harped (toothed) to bond this piece of work: it is an anchoring between two planes as well as an anchoring to the course of the wall.

In mud systems, earth plays all roles and functions. It constitutes the body of the wall (brick or compacted earth), the mortar, and the protection rendering. It is both the load bearing material and the binder, the hard and the flexible. So it is necessary for earth to have sufficient body to satisfy the pressures it undergoes: downward loads, hygrometrical variations, desiccation due to the sun. Mechanical constraints that affect mud in both its mass use and thin layers, the difficulty of guaranteeing cohesion and resistance for a material from a plastic state to a stabilised state, make it necessary to add inert loads or reinforcements, sometimes both. The builder selects the site from where he will extract his material, according to a good balance between the binding material and the load (clay/sand). If the properties of the subsoil are unsatisfactory for his construction, he corrects the material, incorporating a wide range of other materials: sand, gravel, ashes, stone powder, chopped straw, lime. Fibres are used to obtain flexural and tensile strengths; the loads guarantee good compression performance.

- Compact mud walls

Compacted mud walls are implemented by compacting earth in wooden formworks. Each formwork unit is between 1 and 3 m long, and around 50 cm high. The significant thickness (usually 80 cm) compensates for a relatively low resistance and hardness of the compacted material. It is almost always thinned down for higher floors. Its porous structure mass confers good acoustic qualities and a thermal inertia which turns out to be very useful.

Indeed if the areas where it is used are subject to strong variations in temperature, hot, sunny days and cold, nights; mud walls accumulate and restore heat very effectively. The construction material is
perfectly adjusted and sized, the joints are crossed, and the corners processed like the course of the wall. The facings are roughened freshly after unmoulding to favour a good clinging of the rendering.

Primitive in appearance, this technique is nonetheless used for noble, public and religious buildings. Its longevity is subordinate to precautions taken to compensate for its three weak points. First, a base plate is built that is isolated from moisture, then the roof is given a good overhang to cover the building, and, finally, periodical maintenance of the renderings is carried out. It is precisely when the latter is lacking that one recognises the building art. One perceives, for example, the width of the openings and a base plate in apparent stone. Otherwise, when a construction is completely rendered and upkeep is good, the building art can be difficult to identify.

- Adobe brick or terracotta brick

The two techniques follow the same principles for carrying out small, identical and graded elements. However three characteristics bring forth significant differences.
- The lesser resistance of mud brick does not allow for the construction of small pillars, as they would be unable to withstand concentrated loads.
- More resistant to water, terracotta brick can be left bare, even horizontally for sills, cornices, plinths, and any such structures liable to get abundantly wet.
- Lastly, thicker earth mortar is used for mud brick, and lime mortar is used for thin terracotta brick: well bound it is of equivalent resistance to the brick itself.

For the remainder, brick walls have the geometrical qualities of the module (14): the thinnest are 20 to 30 cm thick on average, corresponding to the length of the brick. The thickest seldom exceed 60 cm and can be higher than 10 m, showing that the brick technique uses substantially less material than the stone (up to two times less). It is homogeneous and continuous in the core of the wall, with its parts laid in alternated directions, perfectly overlapping each other, with a regular bearing pressure on the whole surface. (15)

For the course of the wall, brick is always laid flat. One finds a very large variety of modules according to the thickness of the wall. The greater dimension of the module (between 20 and 30 cm) sizes thin walls, the largest layers are made by the alternate assembly of a length and a width, two lengths, two lengths and a width etc. These dimensions are naturally adjusted by the very geometry of the module which is very often two widths long (with every confers good acoustic qualities and a thermal inertia which turns out to be very useful. New floor, when there is thinning down, the withdrawal is half a brick long). All pattern variations are possible on the facing, from large apparent facings only, to the alternation of large and small sides. The systems of laying are systematically opposed in the organisation of the thickness and course by course, aiming for the cohesion of this extremely resistant masonry. To reinforce it further, one also finds (in Fès, Morocco) a piece of crossing wood, as header binder, which anchors thick walls.

*There are three main techniques: rough mud rammed into formworks, small moulded mud brick elements and terracotta bricks*

As the technical origin of brick was the Mesopotamian area, with the same hot climate and dryness as the Mediterranean, mud brick was satisfactory for the builders of the whole area up till the middle of the XXth century. It will thus have cohabited for thousands of years with the more powerful terracotta brick. (16) Indeed, firing is already a proven reality of the Babylonian household, more than 3000 years BC. At that time reserved for exposed facings such as defensive walls, these bricks were manufactured thanks to a technology which survived until the middle of the XXth century. The great advantage of brick techniques, mud or fired, is the possibility of extracting, moulding, drying, and firing when necessary, in situ, on a building site or its immediate surroundings. Clay is available at the surface, just underneath the arable layer. The production of elements is made at the pace of
construction, mixed manually or using animal labour, with or without incorporating sand or ashes to regulate a material that could otherwise crack by shrinking. Bricks are shaped in two-part, bottomless wooden frames. Basic furnaces are mounds of bricks plugged up with earth which cover the elements to be baked and fuel wood. As early as high antiquity, this simple technology made possible temperatures of 800°C and soon afterwards 900°C. (17)

Thus the heritage of the fertile crescent, which spread out and built cities and houses by the thousands, survives in spite of the invention of hollow brick in the mid XIX° century. Even now with the industrialised production of solid brick, it still survives.

Brick is shown with its beautiful course, its mouldings and profiles which can be worked like stone, with its regular, adjusted pointing, sometimes also profiled, and its flattering shades of colour. But brick can also be rendered either for protection or decoration. Its perfectly straight facings make it an ideal support for thin, even, stucco renderings. In this case, it often imitates the elaborate stone course: harped ties with profiled joints, play of the friezes and protruding columns, cordons and frames with mouldings. Its geometry of small modules allows for baroque and neo-classic effects, largely enhanced by the polychromy of painted renderings.

### Woodframe Walls

The wall is composite with wooden elements that bear and transfer the loads. They are built on a continuous masonry base; the filling between the wood frames is usually made from mineral materials. The structures are apparent or rendered.

In Greek and Turkish environments a more expert and refined technique is implemented in the structural concept, divisions and facade appearance. Very often used for floors and noble dwelling rooms, receiving decoration, mouldings and profiles, it is an element "for show" which is exhibited, while the bottom of the building is protected and, therefore, hidden. In the Mediterranean area, the wooden structure produces a composite architecture that allows for an extremely varied range of expressions, playing on volumes and facings. Projections, withdrawals, overhangs, design of the openings, launching of the corbelling, closed or open volumes, bow window or overhang of the whole floor: these elements are elaborate, complex in their construction and spectacular in their architecture.

The skins also exploit all the possibilities that the constructive materials allow. There is the apparent framework version - generally preferred when the frameworks and the fillings are flattering to the eye - which shows the woodwork and its beautiful horizontal vertical and oblique patterns, that play with the colour and the drawing of the panels - schist, limestone, groin bricks, adobe, pebbles. There is the covered version, sometimes of the whole unit, sometimes only of the panels, which proposes a full range of renderings, textures, whitewashing and decoration.

*From East to West, woodframe walls display or conceal their flesh and skeleton in an infinity of variations*

We must also add the contrasts of the lower part of masonry, stone or brick, very often taking up the whole first level, the powerful play of joineries (the technique makes it possible to multiply openings, division patterns, stained glass, shutters), and the oblique caressing of rays which sculpts the facade with light and shadow across the relief.

In zones with strong seismic risk the assembly of masonry + wooden formworks (for inhabited parts) can be interpreted technically as a wise precaution of the builder. In Greece, for example, one finds a system of wooden framework all the way down to the ground, which doubles the lower wall inside the building, allowing for this wall to collapse without compromising the stability of the building in the event of a quake.
Certain alternatives are controllable by the masons when the fillings are assembled with rigid materials constituting a stable body. Conversely, when the fillings are either left out (only lathings and renderings are added) or liable to distort (cob type), calling upon a carpenter is necessary as he masters the adjusting and assembling of panel divisions and wooden wind-bracing. According to availability, one uses oak and chestnut wood, pine for secondary parts and lathing, but also cypress and eucalyptus wood. The sections of wood are a thickness from 7.5 to 14 cm; lathing rendering increases the total thickness. Houses with these relatively thin walls generally do not exceed two levels. Many combined systems, usually with brick, range from 25 to 40 cm thick. Lastly, in Portugal, one finds a totally wooden type of construction in coastal areas; framework and facing, used by fishermen for a short season. On piles, the house is a braced and faced carcass of boards.

**Plant Walls**

In the same range of rustic housing we find hut built with plant walls (cereal, reed...) in certain rural zones of the area, especially in delta zones. The plant material is found on the spot, generally bound and assembled around a basic wooden reinforcement (angle posts, horizontal support elements). These small-size constructions, rendered or not with earth, require regular maintenance. They are living testimony to a prehistoric type of construction. The hut made of branches, with all its variations around the world, is what historians of architecture consider to be the starting point of human construction.

**Openings and arches**

Two different situations: one where the opening in the wall is a simple gap in its continuity, playing only a role of opening, window or door; and the other where the opening is a structure – generally a traditional arch – substituting the wall, when it is a support. Sometimes very similar in size, the two situations can display the same type of arch; it is their function that distinguishes them.

• Openings

The empty gap left by an opening in the wall is a weakness. The loads superimposed on the width of the opening will have “to flow” onto the piers, which in turn pressure the jams, even more so when the piers are narrow. The mason is perfectly aware of this constraint, and it naturally leads him to laying jams more carefully than the course of the wall. In almost all cases, the pier is carried out with higher qualities, which sometimes combine several aspects: larger gauge stone, harder material, better shaping and fitting of the faces for a better contact between the stones, a careful harping with the remaining masonry, a projection which increases the section of this support... The crossing, lintel or arch, is the first element withstanding vertical loads. It is conceived with particular attention brought to resistance. Either it is itself well sized and effectively withstands constraints, without deforming (19) and breaking, or it is assisted by a relief arch which allows the crossing to be less resistant to inflection. In thick masonry walls, windows are under the lintel, it being the more rigid face of the façade. Rear lintels are less elaborate, and often closer to a formwork than a beam, often made with simple branches, for example.

Two types, three materials: lintel carried out with a single element, and lintel made up of separate elements; wood, stone or brick. In fact the five variations can produce all sorts of assemblies. With ashlar there is unity. Lintels will be cut, either a monolith stone, or a separate element arch, a Roman or low arch, or a flat band. (20) From hewn stone to rough stone everything can be found: the above, but also brick and wood. The brick wall more often uses a brick framing, but we also find ashlar, as the two accurate, square shapes associate well. All these types of masonry make large openings possible, builders don’t appear to be held back by technical impossibility, only by provisioning or budget (21) constraints. Up to 2m in width and 3m in height, the builder controls the execution and stability of these large building frames perfectly.
We also find two opposing tendencies: first, playing it safe, when using an almost oversized lintel associated to a relief arch, secondly, boldness when using a simple board lintel very often surmounted by a crack. The crack shapes naturally as an arch, attesting that the loads running down from the top of the opening are distributed laterally, isolating this pseudo pediment now resting on its own weight on a sagging formwork. Other types of masonry are less perfect in texture, cohesion or solidity, generating limits and thus smaller openings. It is the case for adobe brick, compacted earth and dry stone. Dry stone is only found in monolith shape for floorings. It is usually thin and short and not very resistant; openings must therefore be rather narrow. A relief arch is necessary as soon as one tries to widen the opening. (22) In mud techniques, a full wooden frame is often used. It is a pre-assembled and rigid device which compensates for a material that is particularly fragile when exposed to moisture, and which can soften and deteriorate, notably on support levels and arisises. With these three techniques, windows are narrow, well under 1m, the door being the only large opening.

Finally, in a wooden framework technique, openings are constructed with wood and the juxtaposition of a series of windows doesn’t pose a problem, as many horizontal elements bear and distribute vertical loads.

_Whether they be Roman or Arab, our Mediterranean arches are both shelter and opening: a borderline between blazing exposure to the sun and soothing, welcoming shade, as well as a proud achievement_

We cannot close this structural description of openings without mentioning that very small windows (for ventilation, thermal protection against wind, cold or sun) are much preferred in the Mediterranean area. We must also add that the door is for both show and protection, playing a highly symbolic role: it is monumental by its dimensions, the framing and often the crowning are made with nobler or more architectural materials (mouldings, sculptures), ornate door frame and powerful iron fittings. (23) The opening isn’t only to give light, it is also an observation post, a social watchtower, the last private zone, sometimes exteriorised by overhanging onto the street. Balconies, low round belly Andalusian grids, are partly to allow a lateral view, a version where watching is reciprocal. But the corbelling in Ottoman and Arabic traditions allows for quasi strategic watch points from the openings onto the streets, hiding the observer behind the grids of the “moucharabieh” or the windows of the living room. A savoury mixture of privacy, from my intimate space, and at home but in the midst of others, an ultimate borderline between outside and inside... (24)

**Arches**

The large arch, when it is a support (with pile, capital or bases, alone or in series) is a carefully drawn and adjusted body, freeing space by effectively replacing a wall or a beam. We refer here to the arch, which crosses a span between two specific supports. We further develop this when studying arched areas, vaults and cupolas. Intended to undergo significant strains, the arch is made of hard and regular materials like ashlar and fired brick. (25) Widely used in monumental construction and structures, which is not the subject of this project, the arch is also present in traditional housing architecture. Although smaller in size as it does not carry massive masonry, it remains a highly technical job requiring great skill.

Plain (semicircular) and segmental arches are of Roman (an Orient legacy) and medieval heritage. They give preference to stone whenever possible, resulting in a heavy technology and the use of formworks, which are essential for realisation. The variations of the arch design and shape are liberated from simple forms thanks to a technique using brick, which gives the builder considerably more freedom. It uses light modules combined with appropriate mortars, enabling the skilled mason to build without a formwork. This is an Arab-Moslem heritage which derives more from Eastern tradition for the segmental arch, and more from Western tradition for the Moorish arch.
Among the great variety of our area, we will study two examples. In Morocco, incorporating both influences, we find several basic models with very different heights for a same opening. Two slender models are the kharna and the mechaouk. The first is a Moorish arch with a height/width ratio of 7/10, the second is a segmental arch, even higher with 8.5/10. (26) A “bâtière” model, rakhou, 5/10, equivalent to a semicircular arch, and another even flatter, mekhouassar with a ratio of 2.7/10. These profiles are made of curves and counter-curves, very often being denticulate. The realisation of these four arches, including the hanging parts of their cupola (one speaks of an arch with 3, 5 or 7 "noses"), is executed without formwork, sometimes using a simple temporary wedging to hold the otherwise unbalanced element while the mortar dries. In the North, three-hinged braced arches, semicircular arches, straight or three centre arches (basket handle arches) are comparable in height ratios, but they are assembled using a formwork.

The North African examples have spans up to 5m, for a thickness of 60cm. In the North and East, you can also find spans of a similar size. On a smaller house scale, large Middle-Eastern iwans develop on two floor levels, often with spans exceeding 6m. The large mediaeval arches supporting staircases or opening onto courtyards in Rhodes or Acco (the former Saint-Jean-d’Acre) are also quite ambitious and impressive. (27) Various simple tricks are used with brick to improve strain dispatching and to help the mason build without an arch formwork of any kind. The mason widens the top of the pillar by making a trencher with several corbelling bases, next he assembles as many overhanging horizontal bases as possible, trying to start the radiant laying as high as possible. In so doing, the thrusts of the arch are at a level where the solid mass of abutment is much broader, assuming the strains, and making it unnecessary to over-size the pillar.

*Renderings with lime or earth are found everywhere. This essential characteristic, strewn throughout the Mediterranean area, reminds us of a technical culture shared by all*

Similar in function and scale to the riwaq (gallery) and iwan of Palestine and Syria, examples in Cyprus provide a good illustration of how arches are used in a traditional house. Large segmental arches are used in two parts of the construction. First, to carry the external gallery on a series of arcades; and, second, to double the span of the living room, as in the case of a hollowed partition wall. In the second example, the arch is an intermediary support which compensates for the shortage of wood by replacing a beam which could measure from 6 to 7m. The curve of these segmental arches is created by a constant ray proportioned to the crossing distance, with a ratio of 2/3. As the height available varies according to each building, the general profile of the arch is more or less streamlined, narrowed or shaped to an almost semicircular arch. This adaptation is decided on by an expert. He traces out and cuts (both done on the ground), and assembles the structure. He builds as high as possible without a formwork, then, when balance is compromised, he erects a brick formwork, which finishes the shape of the arch up to the key. The stones of the arch are then laid with plaster, poured in channels that are dug beforehand on the contact faces. In order to release as much space as possible, the arch does not go down into the ground, but is pressed onto two bases in side walls, approximately 1m high, just enough room for a piece of furniture. Outside buttresses are essential to retain the thrust of this great structure with broad legs that are not locked into the house. Moreover, for good linking, walls, arches and buttresses are assembled simultaneously. The keys are not shaped on the extrados, allowing for a better harping with corner pieces of the masonry.

Porches, gates, European covered streets, souks and galleries are all built with arches throughout the Mediterranean area. Their profile is conditioned by the available height and bestows their elegance. (28) At the end of its life span, when a building is down to a ruin state, the arch is the last standing element: a proof of its sturdiness and technical mastery.
WALL COATING: RENDERINGS AND WASHES

Renderings

If the wall is rendered, it is initially for the functional purpose of preservation. Thereafter, this layer which is applied and finished in a variety of ways can become the vehicle for specific ornamental expression. The need for coating is directly proportional to the resistance of the materials of the wall support. The masonry most sensitive to water is found in systems using mud, rammed earth, cob (earth and plant mixture) and adobe. These systems are generally coated. (29) Then we have bare stone masonry. Due to the irregular shape of its modules, a significant part of the mortar, whose porosity to water is great, is exposed in the facing making it all the more necessary to render the wall. Also, protecting soft limestone is essential as this most commonly found stone in the area is quite porous and, therefore, sensitive to water.

We observed that since immemorial times, Mediterranean masons have used this waterproof rendering on soluble, porous or heterogeneous supports to stop beating rain before it penetrates and wets the wall. This concern is present everywhere but in varying degrees: from rather thick rendering covering the whole support, to rendering which fills the gaps and keeps stone heads visible. We also find thousands of square meters of bare stone wall which were carefully rendered in the beginning, and later lost this protection with time and wear. Patches of rendering are still visible in Verona under roofs, which were not deemed necessary to reconstitute. The technical perspective, implying that brittleness to water makes rendering necessary, is therefore contradicted by reality. We can probably interpret this as a competition between two time scales: a man’s life is only a few decades, whereas the degradation process of a poorly protected surface is sufficiently slow in these climates to go without maintaining perfect waterproofing over extended periods of time. Since we can do without rendering, we must also consider that it attests to an ambition of another kind. When stone masonry with sharp joints or with fired brick is rendered, it is more to satisfy an aesthetic intention than to answer a real need for sanitary protection.

The thickness, grain and colour of the aggregates, the tools for applying and finishing, produce a great series of aspects that we can classify in four families.

First, a minimum version starting with a simple joint (30) goes all the way to projected/intersected mortar. The mason throws mortar with his trowel, covers the whole surface and levels, removes the surplus with the edge of his trowel. The result is a rather coarse aspect, without any concern for surfacing. The colour is that of the binding material, and of the slightly unsieved aggregate, coarsely granular. Fast work, completed in a single coat that ensures the protection of the support. It is the strategy used, with minimal effort, when one does not want to leave the facing bare. A rather rural and rustic system which isn’t very common in cities where a more urban quality is desired.

More elaborate and very present in all the Mediterranean countries, we find smoothed renderings - very ancient - sometimes replaced by floated renderings with the emergence of cement. They can be applied to the rendering described previously, and are in that case used as finishing. This version has two layers. Smoothing is the obvious stroke and skill of the mason since Antiquity. He applies materials with a trowel, a tool with which he can tighten, level and obtain this inimitable finish of fake flatness which sings with oblique light, delicately animated, like the surface of water or sand. He gives this firm touch of the tool whilst keeping the softness of plastic-like mortar when applying. He reveals the coloured grain without pasting it. He has an elegant, elaborate, yet natural stroke. Every day in our contemporary world, masons smooth and caress their wall when they use this traditional lime, fat or thin, which has defined the trade in the Mediterranean for ages. (31) Cement used as a binding material dries more quickly and doesn’t allow this stroke. To level and finish, the float replaced the trowel: the flat surface is parallel to the wall, a circular rubbing spreads grains, producing a stiffer impression. (32)
Stucco renderings are even more elaborate, though far less frequently used than the two preceding categories which are dominant in the Mediterranean area. These very thin renderings - never more than 3 mm - are very carefully proportioned in binding material and incorporate fine grading aggregates (marble or stone powders, crushed broken tile). Vigorously compacted with a metal smoothing tool or sometimes a pebble, they are always applied on a prepared rendering. They can be carried out in a single coat, simply to fill the grain of the support layer, or in two, three, or sometimes even more coats. These very sophisticated Mediterranean renderings produce alternative stuccos. The sgraffito, Italian, Catalan, but also Greek, superimposes two or three coats, each coloured differently, then partially scratched according to a motif, thus forming an image with two or three tones of grey (vine black, ashes..) and ochre. The tadelak, more often applied indoors, produces a North African, monochromic white stucco, polished and shiny. Or when tinted in the mass of the material, stucco renderings can imitate brick, with re-carved or painted joints.

From a basic single coating protection to the affirmed multi-layer stuccoes, renderings can be applied for strictly functional reasons or be the expression of a delightful and elaborate architecture

The rendered coating is a fascinating piece of work, as it enables the builder or user to alter everything: to remove the bare aspect, to give unity to the structure, to play with the colour of local sands, to show what doesn’t actually exist - using all the tricks of fake materials and the drawing of architectural elements - in short he can "display" in order to show the building in a most spectacular way. He does so with ordinary means - lime and sand - accessible to all. The humblest builder can develop and afford an elaborate, noble architectural language.

It is precisely in this field of powerful expression that we find the fourth family of renderings: projected rendering (33), which seeks textures modelled a la fresco, mouldings and profiles. With this type of facing, the mason associates an elaborate composition of plinths, base plates, friezes, entablatures for the horizontal lines and corner anchors, frames for openings, and panelling for the vertical patterns. Projected rendering is of European inspiration, and quite widespread. With it, we exploit the juxtaposition of the smooth and the granular. Though the surface remains flat, the mason models a relief in order to: imitate the embossing of stone in rustic or granular facings, profile the framing and cornices, create the illusion of columns by the play of protrusions and withdrawals, and engrave fake courses. The Mediterranean men of the art are so familiar with mortar, so convinced that it is as expressive as cut or carved noble materials, that they invented and spread this art of imitation and ersetz. They brilliantly demystified the inaccessible by showing that one can be modest, perhaps even illiterate, but worthy of a brilliant and erudite architecture at home.

The Levant, the Arab-Moslem world, does not use this showy external ornamental language for its facades. It gives preference to a single, sober expression, saving modelled, decorative, engraved, or extremely elaborate renderings for private indoor rooms.

A few gypsum based renderings can be found (34) in Algeria and Tunisia. One traditionally uses these in very dry areas (M’Zab, Nefzaoua) where gypsum deposits abound and where wood for fuel is rare (the calcination of gypsum uses up 5 to 6 times less wood than lime). Named timchent in Algeria, gypsum is alternately both binding material and rendering. It produces grey, ochre or pink tone renderings, today usually covered with washes. (35)

Many earth renderings are used to protect masonry built with earth, like mud earth buildings. The rendering is applied either in one coarse layer, or in two or three layers, with finer aggregates for the final layer. Thickness is variable, 3 to 9/10 cm, flatness is only a mild concern, it is applied with hands or a trowel. (36) Sometimes the finishing layer is a clever application, adding plant sap to the rendering, and smoothing it with a pebble or a flat stone. The surface then possibly creates the illusion of stucco rendering.
Washes

Every Mediterranean country uses white-washings. They are generally made with lime, but also with earth and organic material (cow dung). Renewing is a continuous necessity, often carried out by a non-professional household member. Washes are basic, you only need water, binding material, and a brush made of animal silk or plant fibres. Where animals are present in everyday life, one whitewashes with quicklime to fight against organic infestations. A regular hygiene applied with the cycle of the seasons.

Man's mind is compelled to whiten, wash, clean and refresh his environment. He even limes the pavements in several areas. (37) The religious, family celebrations are a regular occasion to perform this cleaning and resurfacing in the Moslem world. On walls, porches and ceilings, the cyclic repetition of whitening superimposes layer upon layer, by the dozen, multiple coatings as in pastry making, like strata of attentive Mediterranean care, a rendering of homes and buildings that one can read like the rings of a tree; a testimony to the age of the house. With such great attention, masonry is indeed protected! Whether for bare material, stone, brick compacted earth, or rendering, a wash preserves, makes the wall uniform, gives the final touch and impression of a building. It adds this sufficiently waterproof film to endure times of rain without ever wetting the wall in-depth.

On the southern bank, we find a rather basic whitewash whereas on the northern bank, whitewash expresses a more elaborate mixture of colours, a more decorative tendency

Though at first a barrier, the wash becomes ornament. By diluting it further (liming is almost pasty with one volume of lime per one volume of water) with three water shares, the fluidity brings it closer to a paint. Consequently, it is almost always dyed and becomes the instrument of a true resurfacing campaign, playing with local colours. The subsoil of the Mediterranean is a mine of deposits for coloured earth; the finest particles are extracted, decanted, and will constitute the mineral pigment. We are accustomed to the best known of these materials: the ochre yellow of Provence, the golden earth of Sienna, Umbra, Cyprus brown, Verona green and Santorin white. We know that by "burning" pigment we double the colour pallet which results in ochre reds, burnt shades and vine blacks. (38) If these beautiful names echo through our reports, it is because they were specifically identified, and were also the basis of a great historic trade which transported and supplied raw material for the world of Fine Arts. They were products that were distributed through the ages like spice or fabric. But these mineral deposits also provided supplies for construction. Each area has deposits that contain fine enough mineral products for construction: they can be used as miscible pigments for preparing whitewash. Effectively, the chemically basic environment of lime requires using mineral products for the colour to remain stable and persistent: plant or organic coloured products are therefore rarely used for washes.

These coloured washes are more frequent on the northern banks of the area. Do Christian countries like to display and assert their difference, or change skins more radically during each resurfacing and cleaning campaign? The sure thing is that the care and attention brought to the aspect of the façades in Southern Europe are tremendously eased with the multiple solutions of a wash. It enables builders and users to express and reinforce architectural expression. We almost always find at least two tones, a first coat in a pure colour, being more diluted and milky if the surface is large, very saturated when the surface is small, and a second coat of a clearer tone at the contrasting places (framings, ties, frieze). Simple popular veins that bring out the pleasure of the colour for itself, without reference to the colours of the building material. Blues, earth reds, and many among of the fabulous range of yellows, contrast with the off-white of mouldings and profiles. Another more elaborate and realistic vein tends towards trompe l'oeil where architectural elements are drawn in thin lines, displaying shade and light, multiplying the colours to the point of imitating stone veining and grain. On the one hand, the mason's awkward and rustic taste when he swaps his trowel for a brush, and on the other hand an
extreme mastery of the real painter: a wide range of qualities and strokes contained in a technique that, all things considered, is accessible for all.

This matt or velvet quality, this range of mineral colours, though the thin film of lime wears down with slow erosion, always expresses the beauty of substance, making washing an irreplaceable technique.

**Other wall coatings**

In certain situations, a facing out of ceramic or terracotta brick effectively replaces rendering and wash. Nearly an inalterable protection, ceramic remains mainly decorative, as in the North African Maghreb where it is especially used for patios of large Algerian and Tunisian residences, for base plates and wall crowning. Similarly, Portuguese ceramic, "Azulejos", is developed in an infinite pallet of colours, figurative patterns and decorations nowadays considered a true collector's item. Today, however, natural mineral and oxide pigments are replaced by synthetic colours, and the manufactured hand crafted materials tend to disappear, replaced by thinner industrialised tiles.

Terracotta brick surrounding walls, in the Tunisian Djérid (Tozeur, Nefou) display a rich composition obtained with bricks used as modular elements. (39) The geometrical patterns thus produced generate a play of light and shadow which refreshes façades, a great functional purpose in a quasi-desert climate.

**HORIZONTAL CROSSING STRUCTURES**

**Floors**

When not resting on a vault, traditional Mediterranean floors always have a wooden framework. Two main types can be found:

- A thin floor, with joist and boards (or flagstones), where the visible material of the under face is also on the surface. This is always used indoors and very carefully adjusted.
- A thick floor, with a system that superimposes the roofing between joists, a heavy masonry structure, a surfacing or extra rendering. As it is a good insulator, it is found indoors and on roof terraces.

The second model is the most common. The builder must extend a horizontal surface between walls, stable and resistant enough to withstand loads related to housing or storage, massive enough to be more than a mere partition membrane and to effectively isolate two levels. To meet these requirements, the floor is designed as a system – structure, thickness, walkable area – made up of several materials: crossing, linking, filling and finishing. Therefore, one assembles dry and wet materials, a light skeleton and a mass. As for all the other building arts, the same principle using local materials is applied, determining construction solutions and tricks that tend toward the most economical and efficient results. (40)

1. Superimposed flooring made of jointed wooden boards perpendicular to the framework, either left bare (this is the case of wooden architectures, many in Turkey and Greece), or used as a sacrifice formwork supporting a mortar of earth, plaster or lime. a basic role of formwork for the mortar of filling. (41)

2. Between two joists, a short crossing material is laid, a stone slab type (thin like "lauze", schist or slate slabs), tile, terracotta brick, or small wooden panels. This material also plays We find four great systems whose main frameworks are made of wood in the Mediterranean area. What distinguishes them is the way they cross the area between joists.
3. A secondary average sized section framework is laid, perpendicular to the first, in order to reinforce a poured mortar (lime or sometimes earth as in the Maghreb), constituting the heart of the wooden floor. (42)

4. Similar to the example above, a secondary framework made of very small, tight elements makes both the formwork foundation layer and the reinforcement of the earth filling (either poured mortar or hard-packed earth). A large variety of materials can be used to cross the case-bays and reinforce the mortar: small section branches, vine stocks, a blanket of linked reeds, palm tree leaves in oasis areas, or bunches of graminaceous, perennial plants.

The floor is therefore a three layer complex:
- the main wooden framework
- floor blocks (in concrete technique, we would speak of compression slabs) which shape the actual separation – the mass producing the insulation quality between the two floors (the formwork and mortar mass, reinforced or not, make up a distinct unit, separate from the crossing framework: a secondary internal framework).
- the finishing coating, not always carried out, is often substituted by a surfacing and whitewashing.

For the primary structure, span and wood sections are obviously proportional. It is rare for a section to exceed 20 cm in the most common dimensions: 4.50 m to 5.50 m. Squared or rough wood, pine, carob, olive-tree, thuja or cedar. The wooden structure is spaced or tightened according to the nature of the covering material between joists, and also according to how the structure resists the weight of the masonry complex:
- around 60 cm for 3 cm board floorings,
- no more than 40 cm for case-bays made with stone and terracotta,
- up to 90 cm when average wood sections reinforce the mortar,
- tighter for systems using small plant material.

A system of embedding always connects the load-bearing wall and the floor: it is a mason’s logic that prevails.

The central layer, a heavy poured or compacted construction, is never less than 15 cm thick and generally comes close to 25 to 30 cm or more when a terrace is present. The technique of superimposing a load-bearing structure, formwork and filling, leads to greater thicknesses than the technique combining the mortar and its reinforcement (secondary framework). This thickness is great in all cases and indicates that, contrary to modern concrete floorings, which are sized down and consequently thin, the traditional builder doesn’t skimp on thickness: this ensures a good coating of the aggregates and reinforcements, as well as greater comfort (less vibrations, better thermal and acoustic insulation). As the builder is constrained by availability of materials, he invents steel fabric with flexible fibres and short pieces of wood before its time, using an intelligent and effective grid which thickens the unit, as it isn’t using the strongest material. But as this floor is sometimes elevated into a roof terrace, separating interior and exterior areas, this thickness becomes an asset.

The vault is a great cultural and technical accomplishment: the mason must cover a maximum area between two walls using the only mineral material at his disposal

Though less common, traditional floors can also cross large spans: 7 m to 12 m. The simplest solution is to install intermediate stanchion points with posts or columns. If one wants to free floor space, an additional horizontal row is added: a large main beam which supports two spans of shorter joists. (43) But one can also use an arch (Cyprus, Greece) to double the span of a joist module. Other solutions to compensate the loads and avoid sagging include multiplying joisting elements, increasing sections, or connecting joists two by two. (44)
Woods and plants are prone to organic attacks from insects and mushrooms and they also risk rotting (badly ventilated embedding, defects in the waterproofing). To solve these problems and to minimise these pathologies, we find many white-washings and coatings on the frameworks with lime or gypsum plaster. Consequently, the rough, rendered, painted or decorated aspects are not necessarily the result of a more or less noble processing, but an answer to a sanitary requirement to protect structures from dust and to encapsulate constructions which vibrate and suffer from humidity.

**Vaults and cupolas**

- **Vaults**

The alternative to the wooden framework to cross the area between two supports and to cover an area is the vault. This vault can constitute the support of a passage or crossing area, a floor or terrace, or be the roof itself, instead of a framework + roofing complex, with integrated waterproofing.

As for other types of construction, vaults developed because of a combined situation of wood shortage and plentiful clay supplies, generating a technical solution and building art intelligence. The vault was born in the East, in the alluvial plains of Mesopotamia and Egypt, a cradle for so many inventions, amongst the civilisation of the mason, the very subject of our book. It supplanted the preceding system, found in various places in the area where stone is used: a corbeling system which of course enabled covering, but with average results. This obliged constructors to build high, since the flat overhanging projection was limited to the point when the above piece would fall. (45)

The considerable innovation of the vault - we could say "modern" although it is fifty centuries old - is its key system, the organisation of its elements in a volume. Each element taken individually would be unbalanced, but assembled, installed and blocked, elements make up an extraordinary balanced unit. The top of a radiant vault defies gravity. It finds its balance by transmitting forces onto a support - either by its trapezoid shape as a keystone or by an equivalent system - loads are transferred to the neighbouring support element and so on, until finally reaching the stable support of a horizontal base which resists thrust. The problem for the structure is that it is heavy and overloaded. It can collapse at any given moment if the assembly of so many elements is not perfectly executed. It requires great skill (46): we will see how masons gained this extraordinary mastery.

The system first appeared in approximately 3 000 BC, with dried mud bricks reinforced with straw: the first ever modular and regular material. In the marshy areas of the Tiger, the Euphrates and the Nile, it replaced vaults made with curved reed stacks that were rendered with earth. (47) The Greek, Roman, and then Arab worlds became vault users, dispersing it to areas of the Western Mediterranean through their conquests and influence. But it was much later, after the re-conquest of Spain in the XVIIth century, that the Andalusians introduced the brick vault technique to customary architecture in Tunisia. The Byzantines and Ottomans developed cupola techniques during their presence in Palestine and/or Algeria.

There isn’t a single country in the Mediterranean without vault systems. Each construction area adapted the vault to its own materials. We can find these structures carried out in stone – ashlar, rough stones or flat – generally limestone but also schist, mud brick, solid fired brick and modem hollow brick, and in rare cases with wood. Besides ashlar, where the contact between keys is excellent, stone to stone and barely requiring mortar aside from a core channel, vaults are bound with same diversity of mortars as for walls: earth, lime, and plaster. Many small elements as rubble or broken tile are wedged in to lock the angles, holding the square modules (bricks). (48)

As the vault continues the wall, and is very massive at haunch level, it is a solid structure, interdependent with the heavy structure of the building. This is why we most generally see vaults used as a base for several lower levels of construction: basements, ground floor passageways, and mezzanines where it bears the floors. These perspectives of the large arched ground levels are
extremely common throughout the Mediterranean. When it is a superstructure, either the extrados is most important, carefully built and protected with a waterproofing system (tight mortar), as in certain Greek island areas, or its haunches are filled to constitute a roof terrace (Tunisian "štah"). This construction system is well adapted for linear structures: one can multiply it, for the roofing of large public areas on pillars, for example. The Arab-Moslem world uses it extensively to cover mosques, caravanserais, hammams, and souks, while in the Christian world — apart from churches and monuments — arcades and galleries are often arched.

In customary architecture, the most common architectural technical shape is the barrel vault, with its more sophisticated alternative for the builder, the arris vault or the interconnection of two barrel vaults. The barrel vault is generally a semicircular arch, simply because the profile is a half-circle which best transmits the loads vertically onto the support walls: it requires the least bulky possible abutment masonry in order to withstand the horizontal thrust of the vault at the springing of the arch. Conversely, a profile with a straight arch or basket handle arch obliges the builder to thicken the load bearing walls. With the barrel vault, aside from structures with two parallel walls that cancel lateral thrusts, allowing thinning the support wall, systems are thick and walls have few openings. On a static level, the interconnection of two barrel shapes crossed perpendicularly — theoretically on a square level with two protruding groins projecting in two diagonal lines of the plan — functions differently. Each triangular section of the vault, (two points of support at the springing of the arch connected by diagonal lines at the key, the very top, at the junction point of the two vaults) transmits loads onto pillars and no longer on the walls.

*Barrel vaults, basic or crossed into arris vaults, enable generous heights and allow for greater volumes where various bays are juxtaposed*

This allows a complete hollowing out of the four vertical panels; the arched area is limited to four well-sized angle pillars. It is thus a possibility to bring light and exploit the full height of the volume's sides. The now free and open area is quite elegant; it gives an impression of liberation from construction constraints, and at the same time reassures with the strength of its pillars.

Barrel and arris vaults are two regular, symmetrical types. Their rigorous geometrical layout brings forth beautiful, pure lines. Dimensioning is empirical, and know-how is inherited through tradition. The relations between profile, span and thickness were mastered well before engineers validated them scientifically. But customary housing architecture does not attempt great technical performance. The mason does not take risks beyond control. If the spans of the vaults extend from 1 to 7m, 4m being the most common span, it is seldom under 30cm thick at key level (except for ashlar fittings, that enable thinner results). The mason knows from experience that the work will owe its stability only to a perfect cohesion of its elements. When materials are uncut or approximate, the mason adjusts elements according to the profile sought, with precise juxtaposition, tight blocking and crossing of modules, he excels in filling with mortar, owing to the fact that these are the essential conditions for successful realisation and achievement. Elements must not slide or slip: it is the bond between the faces and the mortar that guarantees against risks of displacement. A well erected vault is real masonry work, quasi monolithic, withstanding almost any possible movements that could affect the building, without compromising the structure. (49)

There are several alternatives for the assembly: without formwork, on a basic shape or a wooden arch. Large springers (made with ashlar), as well as irregular stones of all types require a formwork. This formwork generally consists of two strong wooden frames; trusses whose main rafters are round with tie beams resting on supports, making it possible to adjust the level. A bottom layer of boards or reeds connects the two trusses, and makes up the foundation layer of the formwork; they constitute the radiant floor whose regularity conditions the visible face, the intrados of the vault. You move this formwork at the pace of construction when mortars are dry and hard. (50)
Certain areas of the Middle East, due to wood shortage or because effort and energy were not spared, never adopted this system. They proceeded by piling up all materials between walls, and by outlining the template, a full and solid pre-vault shape on which the actual vault was then built, and that had to be fully dismounted afterwards, which meant handling a great volume of materials. Contrasting with this and for brick only, mud or terracotta, masons developed very clever methods of assembly without formwork. This system is based on a construction by section or slice, along a tilted plan; the adherence of the mortar on the face of the brick is enough to hold the element, it doesn’t slip and can then receive elements on top. To shape the arch, it is necessary to trace the profile, but not in space; on a support, a vertical support structure, the pinion wall. A radiant wire extended from the centre of the arch produces the slope angle and position for the elements. This very clever trick is still used in Egypt and Morocco. In Portugal, Spain and Tunisia, one uses the same systems without formwork, but also an alternative which positions bricks flat, in particular for cloister vault arches, a pseudo cupola with a semicircular profile arch and four panels on rectangular or square plans. (51)

• Cupolas

Cupolas and all dome shapes (52) are roofings whose profiles are semicircular arches, drop arches, lancet arches, and Moorish arches attaining parabolic profiles which are adapted to cover a square area. The structure is conceived from a vertical revolution axis positioned at the centre of the volume. The technical problem for the builder is to go from a square plan to a circular plan. The transfer starts at the springer of the arch where the angles of the square are cut and go into an octagonal plan. This geometrical shape approaches that of a circle. (53) Four new supports thus created hang over the empty space and are built like a structure in the area volume. They can be carried out on a support arch, built on the faces of the two right angle walls; this structural element is called the inlet. They can be assembled as a pendentive, a concave triangle built with a gradual corbelling, from the lower angle of the two walls to the base of the cupola whose layout is a quarter of a circle. The pendentive solution makes it possible to cross over directly from a square plan to a circular plan.

As for radius vaults, all materials and mortars are used. For housing, the vastest covered areas are made with brick, up to 12m in Algeria. Stone cupolas seldom exceed 6m. Egypt, Palestine, Jordan and Tunisia are common users of this technique. Today, its technicality and slowness of implementation limit it almost exclusively to restoration. Small openings can be made for light, either at the key, or at the base of the cap. (54)

It is primarily for large public monuments (mosques, khan) that Ottoman building arts, inherited to some extent from Byzantine, produced ashlar cupolas of exceptional dimensions and quality. The qualities of brick, a relatively light element for a great sealing surface, a powerful adherent element thanks to the moulding roughness (formerly handmade) or holes today, make it possible to work without formwork: the element is almost instantaneously held into position, clinging to the mortar (sometimes a reed temporarily holds the element in place, a precaution until the mortar definitively adheres to the brick). Another technique consists of making the four arches on an octagonal plan, then filling the eight panels with material, flat or in an "umbrella" shape, revealing the lines. The other system, without formwork, piles up concentric bases and finishes with an annular key, an opening that lets light in.

On a different scale, we find cupolas in all countries, used in the manufacturing of all kinds of ovens, but usually in quite smaller dimensions, between 1,5m and 2m, sometimes with uneven profiles which do not display the splendid technical control of the South bank.
Frameworks

• Stacked Systems

Flat roof systems are described in floors and flat roofings. Here, we focus our attention on frames or frameworks that bear sloped roofings. The most common situation by far in the Mediterranean is a tradition of stacked frames. It is only in the past two centuries that the influence of A-frames, well established and mastered in septentrional Europe, spread moderately throughout the Mediterranean area.

If Tunisia and Morocco do not report any traditional frames, all the other countries of the area do. From very basic systems as in Jordan, where a central post receives the main rafters: we could say it raises the floor of earth roofing into two pitch slopes (system introduced in the XVIth century, in the Ottoman period and later given up, because of wood shortage). Builders used wood to bear the roof, seeking minimum functionality, without exploiting the range of the material’s potential that elsewhere generated highly sophisticated building arts. Even under Ottoman influence, which used wood with refined technology, the stacked frame seems a relatively oldish type of building, a kind of slackly used process limited to efficient roof waterproofing. It is clear that the builder concentrated his know-how on large and carefully braced vertical frameworks, and on floors, particularly all the corbelling systems of wooden floors on a masonry base, on crafting ceilings or multiplying openings for the façade, on integrating furniture elements within the structure. The area of the roof is not regarded as a useful or exploited space, nor it a display of technical expertise. It is not a question of skill or proficiency; these are clearly expressed elsewhere in the building, at a very high level. Perhaps one reason is that slopes are weak in the area, and the building undergoes little strain due to direct exposure to wind. The frame profile of slopes is a mere limit for rain drainage: it is just a question of raising the roofing with any system of wedging for the sloped framework. The builder apparently worries neither about habitability or circulation in the roof area nor about a systematic wind-bracing of the unit (in these areas, a system of roofing with four slopes produces a rather good natural rigidity of the unit). The situation is different in Southern Europe, where the roof is often used for storage: one is more attentive to limiting the number of posts supporting purlins or main rafters.

The simplest system is with purlins only, restrained in the peripheral pitch walls or on intermediary supports. In both cases, the space is divided at the maximum length purlins (beams) allow, though seldom more than 5m. The intermediate supports are sometimes posts, freeing space on the floor, as we can see for sheep-sheds in Cyprus.

The more elaborate stacked truss has two oblique principal rafters assembled on a vertical post (king post), resting on the centre of tie beam: the longest element which crosses the area between the two runoff walls. The king post carries the ridge, the principal rafters carry the purlins. Sometimes two struts relieve the sag of the principal rafters, and are assembled on the king post or the tie beam. The characteristic of stacked trusses is that the whole weight of the superstructure rests on the tie beam.

The mastery of mortar (thickness, layer, compaction, and protection) enables the mason to make a horizontal waterproofing using porous materials

These frames in “tas de charge” (load mass) consequently imply using a large tie beam (greater than 30cm) requiring the purchase of an expensive tree. For this reason, this element is very often undersized and tends to sag: it is preferably used in the roof attic space where these deformations are not disturbing. The spacing between trusses is equivalent to the span of the purlins: these horizontal elements used at maximum span sag under the weight of the roofing. The result is a picturesque deformation (caving in) of the roof, where trusses look like vertebrae, which makes them easy to spot from the outside. The multiplication of trusses frees large areas as no lengthways supports are
required, while the maximum length of the tie beam determines the transverse limitation. Depending on the availability of wood in the area, ordinary buildings seldom exceed 6m for the inside thickness (4.50m is most generally found). An alternative consists in concentrating the load of the tie beam vertical to the partition wall. (55)

Aside from exceptional buildings which require importing large wooden elements, only local species are used such as oak, chestnut, cedar, pine, ash tree and sometimes olive-tree. Very often the frame does not produce a regular squared wooden pattern, but an assembly of stripped trunks. The assemblies themselves are relatively basic: half-lap, simple notches, nailing, or simple binding as in Algeria. Although these trusses are assembled in triangles (the etymology of truss, ferme = fermé = "closed" in French), looking like A-frames, they by no means have either the performances or balance of an A-frame. Visiting these basic frameworks brings forth their limitations: many elements are broken because of bad sizing, bad sags are more or less compensated for, by impromptu day-to-day reinforcements using splints, adding braces, posts or additional struts.

- Assembled Triangulated Trusses

Elaborate frames, developed as of the late Middle Ages in a Northern Europe widely covered with leafy trees, where constructions have very pointed roofs for climatic reasons, and where the roof attic space is both used and lived in. These frames were developed by the art of the engineers of the XIXth century, which made them considerably lighter: they were little found in the Mediterranean area. The rigid and resistant frame of the triangulated truss, where assemblies are very finely adjusted, where the balance of forces is calculated with extreme accuracy between compressed elements and extended elements, where there is no more inflected element, will develop in colonial times for new and very specialised buildings, with regular geometrical shapes, such as factories, warehouses and large public buildings. The use of this technique, notably more elaborate and which results from calculation, calls upon a trained and skilled carpenter, with an expertise that the general mason generally lacks. (56) Moreover, our Mediterranean roofs have few problems with complicated openings like windows or attic windows, whose framework and waterproofing generate complex connection problems for a non-specialist.

If restoration conforms with the original systems, rehabilitation does not always respect them. The modern world of components prevails today. Roofs with concrete floors are made with metal beams, hollow modules and slabs; slimmer trusses are made with pine boards nailed or stapled to pre-shaped metal connecting pieces: these illustrate a similar process of a standard, simplified, if possible maintenance-free technology.

**ROOFTINGS**

In the Mediterranean we find two types of roofing profiles: flat and sloped. Vaults and copulas are a third category, described above with floorings and crossings, as they are both load bearing and covering systems. For flat roofings, we can distinguish systems including a terrace and for sloped systems, those having tiles, stone, and on a small scale, metal sheeting and plants.

*Round tiles have been anchored to the Mediterranean landscape since antiquity: their colours, graphic undulation and shades perpetrate a powerful emblem of our architecture*
Flat roofings

Flat roofings are found in the driest areas, having very weak slopes, under 5% to evacuate water, and requiring permanent maintenance, which is also the reason for regular transformations. Flat roofs go back as far as antiquity, even if some local introductions are in fact Arab, Ottoman, or Venetian contributions. Among flat roof characteristics, we can also note the necessity of high skill and proficiency on behalf of the mason as well as the particular thickness of the waterproofing complex.

The technique of compacted earth is still commonly found in Morocco and Palestine, in rural plain environments. (57) The earth floor is laid directly on a wooden floor or a bed of branches, leaves, algae, or clay, often mixed with lime and reinforced with fibres. Realisation is carried out in layers. Compressing and protecting the roofs with a wash contribute to the waterproofing, but as all these materials are soluble, a regular checking to fill possible cracks is essential. Nowadays, we can find an intermediary plastic film or bituminous material under the blanket, to delay and reduce maintenance.

The system using lime mortar differs very little from the previous one. It uses aggregates for the solidity and the compacting of the layers. (58) These works, intended to withstand strain and pressure, are very carefully prepared, dosed and implemented. Globally, this system is more resistant and tighter.

The know-how with earth or lime necessarily got more and more elaborate with time, to obtain better waterproofing from porous materials and for horizontal shapes. Here we reach one of the highest levels in traditional building arts. This mastery which calls upon permanent maintenance, disappears with concrete, as concrete requires little or no maintenance. Finally, we find many other systems still in use: covering blankets with calcareous flagstones, terracotta terraces built on earth, sand or mortar. Traditionally speaking, porous products can be rendered, but today tighter materials are preferred, like terrazzo cement (Algeria).

In flat roofings, we can find two methods for connecting wall and terrace. The most common is a pitching of the roof between acroters. A peripheral channel towards the gutters then collects rain. The waterproofing and top of the walls are particularly carefully implemented and maintained. The other type of connection is a cap covering, with a slight overhang of the roofing for drainage, throwing rainwater as far as possible from the wall, and avoiding runoff on the wall. In Morocco, this is a very protruding complex of branches (almost 1m of overhang) that reinforces the earth blanket, with slightly drooping edges: these look like huge brooms and they drain rain. This is a rustic and efficient version of a fascia board.

Sloped roofings

- Roofs with terracotta tiles

These roofs were developed as early as antiquity and result from the simplification of the Roman system which used an imbrex, a large U flat-bottomed tile, and a tegula, a half-round top which covered the joint between two run off tiles (this system is still very common in Italy). The Mediterranean opted for a system of round (Roman) tile which uses the same module, alternately laid for both drainage and covering roles. Only the dimensions vary according to areas (from 18 to 60 cm). The average tile is from 30 to 50 cm long, slightly truncated to ease covering, the best slope profile is 25% to 35%. (59) It is laid dry or built with a thin lime mortar, on wooden battens or a vault. It is a very adjustable product, which can adapt to a series of constraints (irregularity of the support, insufficient slopes, strain, or correcting bad squaring). Its shape allows for play in all directions. Tightening rows, covering tiles, shaping them into bargeboards and shortening them for waterproofing... this flexibility is a quality and a defect: elements can be blown away by the wind, they can rock, tumble or loosen. The manufacturing itself is often heterogeneous in a pre-industrial tradition, tiles can suffer from porosity and weakness of thin terracotta, undergoing the combined
damages of sun, water, freezing, or organic agents. Roof upkeep and maintenance are consequently essential on a regular basis and especially after bad weather. (60)

The builder traditionally does not use a gutter, but always prolongs the sewer beyond the wall in order to keep it as dry as possible. The overhang is made with a jutting out of rafters and battens, with a cornice of stone, brick or plaster works on lathes, or with a Genoese cornice. (61) The vast variety of provisions for overhanging wall/roof connection, which are first a purely technical obligation, produce an architectural language of great quality. Since the jig-sawrafters, sometimes radiant around the hip rafters, to brick lining with corbelling cusps in the Western Mediterranean, to painted cavettos in the Ottoman tradition, roof connections are a sign of dignity which refers to monumental expression.

All these alternatives express the traditional crowning of a building in their own way, a common heritage of the cornice, final moulding of the entablature, which projects its mouldings surmounted by a fascia board outwards. The powerful shadow created by the structure further enhances this summit line.

The family of round tile roofings is one of the trademarks of the Mediterranean landscape. Everyone is sensitive to its amazing beauty, with delicate nuances of colour - straw yellow, ochre, red - expressed by the hand-crafted earth, the lichens and moss which creep across it with time, over the regular and nevertheless random waves of its shapes modelled with light and shadows. The sight is both uniform and varied, across these roofs that seem swept like fields. Persistence is the most striking and manifest evidence of its qualities.

Yet another mineral product, tiles are closer to the field of a mason than a carpenter or roofer. It changes little in shape. Industrial production (62) manufactured a thinner and more regular module, with a much smaller range of colours. For the restoration market, Europe now manufactures artificially weathered tiles, incorporating oxides and pigments. Its industrial heir appeared in the XIXth century, the so-called mechanical tile, named after its interlocking system. Marseilles was the main centre of production, and it was massively exported throughout the Mediterranean area. Used as ballast for ships at a very competitive price, it was quickly distributed and is therefore presently considered a material of the Eastern Mediterranean tradition. In Europe on the other hand, it is seen as a product for suburb construction, and in the Maghreb, a survivorship of the colonial era. It has the qualities of all manufactured goods: it saves on material and, therefore, on weight (35 kg/m²). It is more solid as a result of controlled firing and provides a wide range of additional elements like half tiles, ridge sheathing angles and ridge tiles. The esthetical defects are an overly uniform colour, and poor flexibility to accommodate imperfections of a support or shape. Yet it is still laid 150 years after its earliest implementations.

Traditional and modern construction techniques still co-exist: we still find men of the art who master both. This constitutes a major asset to train the next generation of builders

- Stone roofings

Roofings with schist or slate slabs are especially present in Spain, France and Greece. (63) This technique has been in practice since the Middle Ages. It adapts to strong slopes, usually ranging from 25% to 40% in the Mediterranean area. Depending on the local subsoil, slabs are made of schist or slate and are thinner than limestone slabs. On the roof, one uses a naturally broken or split material, both heavy and fragile, in large modules. (64) It is reshaped as thin as possible to the break point limit in order to remove weight and the irregularities on the surface. These slabs can be laid on any support, on large frames, or vaults. They require a strong covering of approximately two thirds, either on a stacked system, wedged or blocked with mortar, or on a pierced/nailed or pinned system.
The bargeboards, ridge sheathings and sewers get the largest modules, all other surfaces are equipped with average and small size modules. The challenge for the roofer, stone cutter/mason, or nowadays specialised craftsman is to obtain efficient waterproofing from a product which is irregular in size, side, surface texture and thickness. For the ridge sheathing for example, no shape can cover the connection of the two faces. It is therefore necessary either for the slope exposed to rain to overhang the other, or to harp the higher elements of each face, notched one in the other. That generates very astute technical details, as in the great overhanging of the bargeboard with an interrupted slope to slow down water flow towards the sewer, and to make it possible to butt the smaller modules against the largest flatter element at the bottom of the steepest slope.

Large limestone slabs are perhaps the roughest, least man processed product used in the construction industry. Their use for roofings represents a borderline technique that implies a regular control of stone position, wedging and sealing, as well as a checking for pieces that might have slipped or split by freezing, or that porosity does not compromise the waterproofing. In spite of these constraints, this work is still enormously appreciated: it is rendered elegant by the beauty of the material and the vibration of its modules. Moreover, it gains qualities with time, imitates wall patterns, wall techniques, and natural surroundings, blending it incomparably in the landscape. It brings forth a powerful and reassuring vision of a strong construction, decorated with emerging stone chimney stocks and crowning. It is however a heavy and imperfect product, and will perhaps be saved by the vast modern range of reliable waterproofing products (a range of ribbed metal or bituminous sheets) that one now places under roofing materials to free the user from constant maintenance.

- **Plant Roofings**

Very rare examples of thatch roofings survived in the area, primarily in plain or littoral zones. We find them on very poor and often only seasonal housing of farmers or fishermen. Quite sloped, (from 45% to 120%), their balance is between a reasonable exposure to wind and the need for quick water run off to avoid getting drenched and rotten. According to availability, one uses gorse, sea reed, wicker, graminaceous plants, corn, rye, or rice straw. Flattened thick bundles (10 to 25 cm) are quite insulating, 40 to 80 cm long, covering length is at least one third. The weak points of plant roofings are clearly fire hazard and the brittleness of the bonds that fix the bundles to the frames. On the ridge sheathing, mortars can improve the waterproofing. The technique was used in prehistoric times; the restoration world considers it as a surviving testimony.

- **Sheet roofings**

We are only listing and quoting here: we will further develop the subject of sheet roofing in transformation processes as they are not yet “digested” within traditional architecture, unlike flat mechanical tiles which have been used by over six generations of builders. (65)

**THE MEN**

**Living skills and proficiencies**

Traditional architecture is built, maintained, and today rehabilitated by men. Construction such as we described in this building arts chapter has become confidential; from now on, the stratification of the models and traditional constructive processes is primarily used to maintain and adapt, sometimes to restore. Questions of skills and proficiency, the capacity of experts to assure a technical and cultural continuity obviously raise the question of training – training would be the most appropriate modern word to describe the system by which one acquires knowledge and know-how.

We must immediately declare that training specialised in intervening on old constructions is failing in the Mediterranean. In terms of quantity the poles of specialised training are far from numerous considering the cultural challenge and market activity. But also in terms of quality due to a tendency
to reduce traditional architecture to a sum of technical characteristics instead of a built work considering a construction as a whole entity in itself. If training enables to master ancestral techniques effectively, and consequently allows for satisfactory work, it only acts very little on the whole construction action and the final quality of a completed project. (66) Should this surprise us in any way? Training is a tool, it is related to demand. It has no memory, and only reacts to the energy of the moment. And nothing today shows any clear social pressure to trigger the creation of a series of places dedicated to training, when such centres could try to constitute a supply for a demand targeted specifically on the characteristics of old construction.

Probably also because of the surprising and innovative aspect of the subject, there are very few sectors adapted to initial, professional training leading to specialising builders in traditional construction. It is indeed the first time in history that construction completely renewed its ways of building, creating a new trade replacing the former one (we develop this idea in more detail in the chapter dealing with processes of transformation). Moreover, for only a century, public systems have replaced corporations or professions in organising training in all the western states studied. Indeed in the past, the world of construction used to transmit know-how directly to its manpower, adapting day to day, adjusting skill and order to the demand with trades’ great flexibility, compared with national systems of training. As the market is directed towards the production of residences, using massive and modern techniques for about fifty years, the world of trades has had to adapt: it no longer needed to fill young people with local construction tradition, letting traditionally trained manpower get old. It is they only who hold the richness of traditional technical culture in their hands.

There remain enough of these men today for us to recover skills, materials and practices here and there, when a clear need for this type of skill and proficiency is expressed. But the age of this population should alert authorities in the educational world, and stimulate perpetuation (67) at a time when restoration will become (and already is in Europe) the second largest market in construction. A market which must establish its own rules for quality. The fact that the rules of traditional construction arts are little or not put into writing reveals how much a reference code describing the good methods, and why choosing this or that one, establishing the standards of quality is necessary in order to control results. This function used to exist in North Africa, through a man having professional authority: Alamine. The traditional world standards will probably no longer be supervised in the future, our societies must find an equivalent successor of this knowledge, with both ambition and result. The challenge for traditional construction, which conquered a patrimonial level in terms of interest, knowledge, respect or sometimes preservation, is to reach quality evaluation and assessment in a corpus which would be based more on a sociological and professional consensus, rather than a regulations system which always proves less efficient.

Marginal and scarce, retired craftsmen who are the heirs of our building arts are often the "last chance of survival" for a tradition which no longer regenerates naturally. These skills are fragile, and because they are so little represented, certain countries try to collect, integrate and maintain them within their monument restoration services (Greece, Cyprus and Tunisia): (68) preferring this system to calling upon private companies which has long been the strategy in Europe. These secluded systems are effective for exceptional heritage but do not apply in an unprotected restoration sector. (69)

Along the same lines, it is interesting to consider which majority of actors profit from superior training dealing with architectural heritage. We find many in subjects such as history of art, civil engineering, community services (town planning, patrimony and heritage preservation or development), generally options in specialities, but laid for designers, researchers or managers. Which means in the end that there is no actual training for the workman who works with his hands (except for restoration of works of art, a confidential and high level scientific population). This clearly means that within states, departments in charge of education from lower education to university privilege enlightening their elite group of decision-makers, transmitting heritage related knowledge to them. They do not understand the need to address the world of trades, representing the largest troops working on traditional architecture.
This draws up the trend for national academic systems. For the past one to two decades, failing state systems have been compensated by a rich expansion of continuous training, developing a broader offer of training, perfecting or specialising trades related to heritage, especially in Southern Europe which found the means to finance them. "Lifelong training" is a flexible tool in itself, in tune with trade environment, constantly adjusting to a general market trend. Day to day, it invents new formulas of training and accompaniment for professionals. Quick and creative, innovative and mobile, continuous training is no doubt the best chance to stick to daily evolutions in the field. While addressed to the active professionals, it simultaneously can work near the actors of the command, the design and the execution, consequently embracing a whole task, in a coherent way, from prescription to scaffolding. (70) This is a first draft for a global solution of requirements in training actors. (71)

A mason for the mediterranean

All the diversities pointed out in this book are those produced by men. If a certain pre-industrial society way of manufacturing buildings definitively disappeared, the remaining construction stock is our concern. Today, which expert intervenes on these buildings? What must he do? Is this so different - if one reasons in terms of skill and proficiency - in the four corners of the Mediterranean area? While raising this question in thirteen countries we have reached a common, regional position presented hereafter. On location investigations have revealed a situation we summarised in three points. CORPUS proposes to react with three orientations followed by a conclusion.

Knowing the art of a builder and broadening his scope of skills are two keys to help a man of the art adapt to the rehabilitation of Heritage.

First report: the borders of traditional trades in construction, in a disappearing process, characterise many smaller subset specialities. It is a tendency, which is especially true when a very high technicality is necessary. In parallel, we observed that if simple techniques constitute a local practice, the same individual masters many and becomes the sole builder of the house. First answer: in rehabilitation, it is irrelevant to reconstitute narrow micro-specialities, but better to direct towards a wider profile, which embraces a maximum number of capacities in the hands of a single professional. This is in order to answer the multiform demands of the market since repairing interventions goes from small scale works up to works mobilising a vast range of techniques and materials.

Second report: contemporary construction calls upon almost no knowledge in traditional building techniques. The effect is that ancestral know-how is no longer transmitted naturally to professional corps as a whole. However, pockets remain in areas preserved from modernity, and that didn't substitute their practices. Second answer: there is no definitive crisis in skill and proficiency. In each craft environment, one can find experts perpetrating a traditional know-how: scarce or old, but not vanished. They can be identified, found and mobilised in a transmission network as soon as we act. (72)

Third report: interventions on architectural heritage do not call upon new professionals specialised in traditional construction, but on a corps of general, basic professionals present in the market. It is thus necessary for us to evaluate if these new trades are liable to retrieve the necessary know-how to maintain and adapt to housing construction techniques of a traditional nature, on the basis of current skills and proficiencies. Third answer: recovering a technique or the use of a forgotten material is easy for an expert. This can be done with improved proficiency courses (short, highly specialised, practical). Indeed, a practising expert controls his craft, the pace, behaviour and assets on a building site; he is by no means disturbed by the introduction in a new skill: because it is practical and natural to acquire.

Consequently, introducing speciality segments in "traditional techniques" must become a priority to the benefit of a man who already has a basic trade even if it is modern. The momentum of this
proficiency is motivation. Bringing these principles together would thus be enough – a broad technicality, with experience in traditional construction, or integrated in a building trade – to create a single profile, a working actor, adapted to heritage architecture. This is the mason. The chart hereafter lists the skills of a mason, and draws contours of his proficiencies so we will not enumerate them in the text. Under the effect of our common land and roots, profiles vary little in the Mediterranean area. The only differences to be introduced are the specific alternatives from each local tradition. Thus, between a Portuguese mason and his Turkish counterpart, there are more common capacities binding them than there are differences in the practice of their trade.

In order to sketch the profile and training of a craftsman who is supposed to intervene on traditional architecture, CORPUS used a system of "job benchmark description" connecting two parallel approaches:

- tasks and functions, held by this expert in the frame of his work, and his level of autonomy,
- itemised capacities and proficiencies he must acquire to fulfil the tasks entrusted upon him. (73)

To a professional profile there is a corresponding level of skills and proficiency. Our analysis of the Mediterranean area positions this profile on a customary level: neither at the height of excellent specialists, nor at the bottom of excessively unskilled workmen.
Notes:

1. Mechanical tiles of Marseilles arrived in Cyprus by boat at the end of the XIXth century and were used as ballast by trading vessels on their outward journey. Local craftsmen covered thousands of buildings with this product.

2. Borderlines between trades vary tremendously from one country to another from the mason who implements all mineral materials, including roofing, to the professional bricklayer.

3. Certain maintenance tasks like lime washing of facades or checking a roof, are practices which can be performed by a user or a craftsman.

4. Rough, primitive supports (wall, partition) made from the poorest quality materials and assembled without any particular care, can be finished with splendid rendering, spread perfectly, and decorated with a fake regular stone course, sculpted, modeled or painted. This difference between very modest means and a sophisticated, elegant result informs us of the intention of the builder who uses all available tricks to beat his budget, to produce maximum possible dignity in spite of limited means.

5. Building a vault rather than a floor to cover or cross is not only a question of shortage or abundance of brick, stone or wood, but also a reflex on the part of the builder who implements a predefined solution. For a specific place, specific resources: because there are small differences in available means, an alternative expression in building arts is developed rather than another. A complex, two sided mosaic rich with look-alike and difference.

6. From 3 cm thick schist plates to large granite 50 cm thick blocks, and all the way to limestone or volcanic stones in all intermediate heights: masons use stones which range from 2 to nearly 100 liters in volume and remain nevertheless transportable.

7. Let us stop and reflect, nostalgia or necessary beauty? We grant modern materials "neither the right nor the grace to age well" F. Choay, "The Allegory of heritage", Le Seuil 1992.

8. Very thin wall, 20 to 30 cm, the same stone can constitute the two facings. Less thin, 25 to 45 cm, the same stone is visible only on one facing. Long and short stone patterns are alternated.

9. For the solidity of the unit, the mason is careful to leave a maximum piece of tail on the inside portion of the stones of the wall so the filling can play its blocking role by fastening with the protruding stones properly.

10. The facing of cut or dressed stone wall is not laid in mortar, but laid dry with a space between the blocks which makes it possible to pour fine, fluid and very thin mortar. This guarantees a perfect and regular adherence between the elements.

11. In Algeria, in the Aurès area, these elements of wooden anchoring or damping inserted in the wall are described by the word soumti whose literal translation is "cushion". A lovely image for a work of support and laying.

12. Earth, noble and invaluable material. Such privilege to bear the same name as our planet. Today, however, we tell children: "don't sit on the ground! (earth in French), "Don't play in the dirt, it's dirty!". How can we claim to re-use earth as a building material, if the message transmitted through upbringing doesn't change.

13. Annex buildings, surrounding walls can be built without a rendering for protection.

14. Modules of adobe bricks range from 20 x 10 x 3 cm to 40 x 20 x 20 cm in Jordan (0.6 to 16 liters). For terracotta brick, if Antiquity produced many square modules (15 x 15 x 6, 45 x 45 x 11), sometimes re-cut diagonally in 4 isosceles triangles, it also inaugurated the rectangular format still preferred today (26 x 13 x 9 in Egypt, 66 x 33 x 9 and 33 x 16 x 8 in Persia 600 BC) and according to the following ratio (length = 2 x width). Thickness is between 4 and 9 cm.

15. These qualities of regularity are exploited in mixed systems of stone and brick where one can find a brick row determining levels controlling the level with a regular material, this row sometimes crossing the wall in its full thickness to make up an anchoring of the two facings.

16. Jean-Pierre Adum (Roman Construction, Picard, 1989), points out that Vitruvus, in the first century BC, only mentioned mud brick, considering that fired bricks were only developed to improve the waterproofing of specific elements (tiles, pipes, cisterns, tanks). Temperature is comparable to that of firing lime, allowing for mortars to reach a resistance level comparable to brick. We notice the same parallel concern with the XIXth century, when the control of higher and constant temperatures made it possible to produce more powerful, resistant bricks, but also cements; first mixed to lime, cements supplanted lime in order to satisfy this equivalent block/mortar resistance.

17. The "life duration" of plant constructions is weak. In the Delta of the Nile for example, a fisherman rebuilds his house approximately every five to eight years; this rebuilding is carried out entirely in less than eight days.

18. Indeed, openings equipped with joineries are mechanical structures that are handled daily, and will dysfunction at the slightest warp or deformation.

19. The flat bend is a flat arch, installed with radiant keys. It is the method (Roman) that makes it possible to build a long horizontal lintel, often around 120 to 140 cm, that one could not draw from a monolith stone: quarry difficulty, risk of breakage or obligation for a higher springer, handling difficulty due to weight.

20. One could wonder whether a small window is synonymous with lack of means or technical incapacity, if it is considered useless to over-light an area or if abundant outdoor life and light suffice against frustration.
(22) The Tunisian masons overcame this limit by building trapezoidal openings, broader at the sill than the lintel.

(23) In the médinas, there are few or no openings onto the street, the door is the only sign of dignity or social status of the inhabitant.

(24) “I can watch you whilst you cannot see me, I can contemplate the frenzy of the street from above. From my home, without your being aware, I am filled with city life.”

(25) It is true that high antiquity, Mesopotamian or Egyptian, which created key vaults, used mud brick.

(26) In the mechaouk principle, the profile (shape) of the arch is obtained by subdividing the cord (the span) into 3, 5, 6, 7 points, acting as centres for the tracing of the arch segments: 3 points produce a very slender profile, and 7 a very wide profile. These adjustments within the same morphology are invaluable to the builder.

(27) Baylís, warehouses found in the suburbs of Damascus, are vast naves with two sloped roofs resting on perpendicular walls spaced at purlin's span distance. These walls are hollowed into large semi-circular arches which can cross up to 9m.

(28) An arcade frees the house of its walls, allows for new volumes. The resulting space becomes a transition between the outside and inside, a place both for living and wandering. The arcade stretches into pillars, raises into vaults, defies the weight of the building: it is a proud representation of mastery.

(29) There are however many exceptions to this principle: appendices, surrounding walls or façades without any exposure to rain.

(30) The Greek-Turkish area in particular exploited expressive, ribboned protruding joints, and as they are modelled on rough stone, they have random graphic designs, looking like a labyrinth.

(31) Local performance improvements are sought. For a better cling of the rendering to its support (which becomes the weak point of this technique with time and wear) masons of Santorin and also of Mahora "nail in" the rendering with small apparent stones. This measure for durability became an aesthetic trademark connected to the territory, reproduced afterwards as a sign of identity, but with different rhythm and density: the original reason has been forgotten.

(32) The float also makes it possible to finish renderings with lime. In the Western Mediterranean its use spread for a century, producing flat facings, losing the trowel's flexible smoothed vibration of traditional masonry walls.

(33) One projects the mortar using a broom made with branches of cypress, boxwood, or date palms, striking it against a stick to obtain a projection with a swift and precise movement: from a coarse alveolar grain to a "Pyrolyan dotting", the range is quite vast. One can also whip fresh rendering with a branch to even the texture while tightening it.

(34) In Cyprus, plaster renderings called plaster "of Paris" or French plaster, have been used for a long time and are an older process than we would imagine: a privilege of the islands who benefited from modern goods coming by sea at a very early stage.

(35) The travellers of the XIXth century described urban environments as heavy earth and rock-colours. "In Ghardaia, and in Beni-Isguen, all the arcades are lined up one on top of the other, some whitewashed, bleached houses contrast with the greyish tone of those that aren't." Tumelet, 1854

(36) In the area of Siwa in Egypt, salt stones (kershit), very porous and random in shape led to a construction system with 50% earth mortar. The surplus of this mortar is re-projected on the masonry to fill all the gaps and protect it.

(37) Either a simple, specific frame of the opening or door is processed (white, bright white/whites), or partial surfaces (whitewashed only to chest height, or only the more exposed base plate, more regularly maintained). It can also be limited to the main façade or used on all façades, including roofs and terraces.

(38) In the middle of the XIXth century, in Lyon, Guimet developed a chemical ultramarine blue that was compatible with lime. Produced industrially (an abundant, powerful and cheap dye), first exported from Marseilles, it eventually conquered the whole Mediterranean, making it possible to use this colour in construction. Before, it could only be obtained by crushing lapis lazuli or azurite (brought in from Orient: "ultramarine" means coming from "by beyond the seas" in Latin) at an outrageous price and was usually reserved for fine arts.

(39) Taking into account the tourist attraction of traditional façades in Taza, the local authorities imposed the covering of façades with brick in relief. The result was the plating of traditional decorations onto hollow industrial brick or concrete. A showy dramatisation occurred simultaneous to a progressive disappearance of the less maintained original construction, in spite of commendable efforts by national authorities to preserve a few highly emblematic buildings.

(40) In Tunisia, 2 alternative floors exclusively use palm tree in all its shapes: sized in joists (zouāzī) and boards, downsized in radial portions (samnour), or made in mats (if sira) using the vein and foliage. After chopping and pre-drying, the palm tree is soaked 6 months (tanguu) in a naturally wet and salty environment in order to tighten and compact its fibres. After an additional drying phase it can be cut to size. A sophisticated process to prepare the only available local material, adapting technique to performance.

(41) In Algeria, palm tree feather-grass (seins), curved and forced between 2 joists in a continuous carpet, form the intrados of a small vault made up of stones and plaster (timchent). This type of work braces jointings very effectively.

(42) In this alternative, when the secondary elements are not jointed, a formwork support is used and dismantled after pouring.

(43) One finds cedar imported from Lebanon in countries like Egypt and as far as Portugal for long beams, which are not available locally. They are noble elements that are often re-used. Shortage and scarcity in Jordan, as of the end of the 19th century, railroad rails compensated for the lack of wood; they were in turn replaced by industrial metal beams.

(44) These processes are often used subsequently, as reinforcement.
(45) For corbelling vaults, the overhang of a stone must be compensated by its counterweight, a long and heavy tail, to keep the stacking stable. In such a static system, the loads borne by the vault necessitate solid abutment masses, very large buttressed masonry.

(46) Beyond their construction performance, vaults develop in height, producing greater habitable volumes than floors. These vaults increase inside comfort for inhabitants: the heat can elevate in the volume of the room, keeping ground temperature lower in hot areas.


(48) Reducing weight is the reason for using materials such as coal, hollow materials (amphorae, cylindrical brick) and low density volcanic stones.

(49) Carefully filled and masonry worked haunches associated with a minimal load on the key make it possible to improve keying-up and solidity.

(50) Most vaults are built with bricks laid on their sides. An alternative technique inherited from a Roman method consists in doubling the formwork with a sacrificial layer of bricks laid flat. Rubble and filling materials laid in mortar constitute the actual vault on top of this kind of hull. This system requires excellent mortar and has the advantage of a beautiful regular intrados.

(51) Beyond regular shapes and horizontal generators, the vault technique enables rampant positions, for example, to cover a staircase or to widen into a truncated shape. These surfaces cannot be calculated easily and require a more complex geometry.

(52) The Mediterranean is strewn with cupolas, especially on the Southern and Eastern banks. Cupolas can be spherical or with multiple faces, introducing sumptuous spaces and volumes into homes or public buildings; this splendid geometry combines squares, circles and tall vaults.

(53) This zone of transition can be built in several stages and courses, from 4 to 8 sides, then 8 to 12 or to 16. This is a heightening of the vertical section, a kind of succession of panel drums, always narrowing as it heightens.

(54) In hammams, hollow pottery is incorporated in the assembly, making up a series of light funnels, an analogy to the stars in the heavens.

(55) In Greek and Turkish environments tie beams are made of 2 elements resting on a partition wall: the thickness of the building can be doubled.

(56) Large spans require a supply of powerful materials. Thin sections and industrially sawn materials are not found on local traditional markets. Another type of economic organization in construction must therefore be mobilised.

(57) Pockets also survived in Egypt, Tunisia, Algeria and Greece. In Lindos, the island of Rhodes, the patella are maintained yearly by small heaps of clayey earth stored on the roof terrace: rainwater dissolves them; the earth runs down and clogs the cracks. In Turkey, people leave stone rollers on terraces to facilitate maintenance.

(58) In the Greek kourasani, for a better casting of each grain, broken tile in three different gradations is integrated in the lime paste for five to six days. Once spread, the mortar is beaten and tightened several times (up to twenty times!) with a piece of iron to compress the material to one third the thickness of the layer poured, from approximately 7 cm to 2 cm, until the most coarse grains are apparent. One uses this technique both for a roof and terrace blanket, and the extrados of external vaults. A layer of thick olive oil residue is applied every 2/3 years, producing additional waterproofing varnish.

(59) The proportions are always comparable: a 50 cm long tile has an opening of 15 cm at the top and 25 cm at the bottom, its total height is approximately 10 cm, its thickness ranges from 1.5 to 2 cm. A round tile roofing weighs from 35 kg to 65 kg/m²; the gauge (the visible part) ranges between 2/3 and 3/4 of tile length.

(60) Sorting and testing of the good tiles: the tile must produce a clear sound when it is struck; it must withstand the weight of a man.

(61) A Genoese cornice is an entablature of juxtaposed tiles crowning the wall in several parallel rows (1 to 4), each one corbelling on the previous row (photo necessary).

(62) One also finds concrete tiles, interlocking terracotta tiles with all kinds of alternatives making better fixings and consequently reducing maintenance, improving ventilation of the complex layers which now include a thermal insulator. Corrugated fibre cement plates are also found, which make it possible to save on the lower row (channel) while ensuring perfect waterproofing. The glazed tiles in the North African Maghreb are often green and became a sort of trademark for certain buildings.

(63) Besides earth roofings, stone roofings evoke the mineral aspect of the Mediterranean world.

(64) We find a wide range of faces and thicknesses for schist or slate slabs: from 10 x 10 x 1 cm up to 150 x 80 x 6 cm, producing roofs weighing from 100 to 300 kg/m². More or less rough or reshaped with a tool, schist or slate slabs are pseudo quadrangular or with a round fish-scale or triangular shape.

(65) In the Moroccan High Rif, the abandonment of cereal farming rendered traditional materials unavailable: plant roofings, like thatch, therefore disappeared. Metal sheeting became the new basic accessible covering material.

(66) The questions related to assessing quality are complex: is what constitutes quality space or volume? Is quality the refinement of an elaborate architecture or the taste of a more modest construction, built without an architect? Is it simply the age of a building and the poetry conferred by the years? Is it the case brought by the builder to his structures, to an extent that they still fill their role today? Is it necessary to change a two hundred and fifty-year-old window that still opens well? In other words: what confers respect to one building rather than
another? And what purging, mutilation, or substitution would be harmful? This reasoning, “by default” works rather well in a field where subjectivity weighs heavily. It is necessary to give priority to the construction based on what it evokes and imposes.

(67) It is crucial to revive bonds and links: we must gather the elder craftsmen who are still working today, because oral tradition is irreplaceable. Beyond the transmission of know-how, there is an initiatory dimension: everything revolving around a technique can only survive with human relations.

(68) In the same spirit, the stone cutter school of Tinos in Greece trains workmen later integrated in the restoration program of the Parthenon. It is a purely internal school within Historical Monuments services.

(69) In the CORPUS network, several NGO, training centres, professional organisations became consultant and/or trainers, fuelling all the fields of rehabilitation.

(70) Professional training can also bring architects and craftsmen together, for example, as they always need to understand the gap between what’s on paper (plan, reports…) for some and the real situation on location for others.

(71) Many partner countries in CORPUS seek to establish integrated systems of professional training which link and contact the various actors in restoration: Turkey is ahead in this field, with many interactions already in place.

(72) Certain partner countries in the CORPUS network listed these “resource-med”. We listed all the ways to mobilise them in transmitting initiatives four young people, in every imaginable training framework.

(73) A comprehensive profile chart is also an opportunity to indicate the systems and limitations of knowledge acquisition, formulas for training, control and evaluation of practical know-how, helping to define them all.